ARPA ORDER NO.: 189-1
5G10 Tactical Technology Office

R-1575-ARPA
February 1975

China's Approach to Technology Acquisition: Part III—Summary Observations

Hans Heymann, Jr.

A Report prepared for

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Rand
SANTA MONICA, CA. 90406

The research described in this Report was sponsored by the Defense Advanced Research Projects Agency under contract No. DAHC15-73-C-0181. Reports of The Rand Corporation do not necessarily reflect the opinions or policies of the sponsors of Rand research.

ARPA ORDER NO.: 189-1
5G10 Tactical Technology Office

R-1575-ARPA
February 1975

China's Approach to Technology Acquisition: Part III—Summary Observations

Hans Heymann, Jr.

A Report prepared for

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Rand
SANTA MONICA, CA. 90406

Published by The Rand Corporation

PREFACE

This Report constitutes Part III of a three-part study that addresses the question of how extensively and how effectively the People's Republic of China (PRC) utilizes the great reservoir of technology that is potentially available to it from the most advanced industrial countries. The study is part of a larger research program on technology exchange and technology export sponsored by the Defense Advanced Research Projects Agency.

The study is intended as a first cut at the task of understanding China's technology-acquisition strategy. It seeks to illuminate the evolution of that strategy over the past twenty-odd years; to discover how the strategy is linked to the process of technology diffusion within China; to gain some insight into China's probable present and future rate of high-technology advance, and the degree to which that advance depends upon outside contributions. In a later phase the research will focus on the implications for U.S. security policy, particularly as it relates to technology transfer and export control.

The research has concentrated initially on two of China's modernizing industries, aircraft and automotive. The two industries were chosen as much as a matter of research convenience as for their intrinsic interest; both, however, were major beneficiaries of external technology, and yet developed in quite different modes and directions. Their technological development was examined in parts I (R-1573, February 1975) and II (R-1574, forthcoming) of this series. The present Report, Part III, attempts to provide a more general assessment of China's technology-acquisition process. It reviews briefly the evolution of that process and seeks to throw light on the way foreign technology is related to China's technological growth and to the diffusion within the country of technological knowledge.

The findings of this study should interest those agencies of the U.S. Government principally concerned with strategic export control and technology transfer -- the Office of East-West Trade of the Department of State, the Office of Strategic Trade and Disclosure of the Department

of Defense, the Bureau of East-West Trade of the Department of Commerce, and the Council on International Economic Policy of the Executive Office of the President. The findings should also be useful to those on the staffs of the military services and of the national intelligence community who are concerned with technology assessments.

SUMMARY

EVOLUTION

The People's Republic of China has exhibited wide swings in its receptivity to foreign technology in the course of its 25-year history, oscillating between enthusiastic acceptance and determined rejection. In the 1950s -- the era of close Sino-Soviet cooperation -- China eagerly accepted what was undoubtedly the most comprehensive technology transfer in modern history. During that decade the Chinese obtained from the Soviet Union the foundation of a modern industrial system. In the process, however, the Chinese became heavily dependent on Soviet tutelage and were induced to adopt a Soviet model of forced industrialization inappropriate to China's resource endowment. In the late 1950s, the Chinese leaders began to reject this model and the overwhelming Soviet influence. The Great Leap Forward marked the reaffirmation of a more traditional Chinese nativism and self-assertion. Foreign technology and expertise were rebuffed and a policy of self-reliance instituted. Inept policies, successive crop failures, and the sudden withdrawal of Soviet technicians in 1960 combined to throw the Chinese economy into disarray.

A shift in the early sixties toward priority for agriculture and a return to a more permissive technology-import policy helped to revive the economy. While continuing to stress self-reliance, the leadership undertook selective purchases of European and Japanese plants and equipment, primarily as prototypes for learning and copying. By 1965, the economy had largely recovered from its earlier setbacks, only to be disrupted once more by the turmoil of the Cultural Revolution. The intense antiforeign campaign of that period again sharply curtailed acquisition of foreign technology, and by 1969 machinery imports had dropped to less than one-fourth of the peak levels attained ten years earlier.

Since 1970, the Chinese leaders have turned outward once again for the acquisition of capital equipment and know-how on a substantial scale. No longer confining themselves to prototypes, the Chinese have

purchased large numbers of complete plants and industrial complexes to enhance output in a half-dozen basic industries, primarily metallurgy, petrochemicals, and energy. Machinery imports, therefore, have risen more rapidly in recent years than during any previous period.

Self-reliance continues to be stressed, nevertheless, with at least three objects in view: (1) to minimize China's strategic and financial dependence on foreign countries; (2) to create a self-confident "new Maoist man" and guard against his contamination by alien influences; and (3) to mobilize local savings so as to economize scarce foreign exchange and state investment outlays. The pursuit of self-reliance in these terms has enabled the Chinese to achieve a high degree of technical and economic independence of the outside world. China's own production of machinery and equipment is now so large that imported technology represents only a small fraction (perhaps 6 to 8 percent) of its overall technology accretion. In *qualitative* terms, however, technology imports are still a key factor in the development of the more sophisticated sectors of China's industrial production system.

MODES OF PRODUCTION

Three distinct modes of production coexist in China today: scientific laboratory industry, urban industry, and rural industry. Their interest in, and access to, foreign technology also differ sharply.

Scientific laboratory industry is an outgrowth of Mao's insistence that all research be linked to production. It is made up of small, scientist-guided pilot plants and laboratory workshops established within or under sponsorship of universities and research institutes. Laboratory industry focuses on trial production at the technological frontier, but it also produces sophisticated components in quantity, especially in electronics. Its principal aim is to achieve self-reliance in high technology. Thus, while it greatly values international scientific contacts and information, its demand for foreign technology is relatively small.

Urban industry, the principal claimant for foreign technology, consists of two subgroups:

(a) Large-scale basic and military industry, under central control. This group includes all of the capital goods plants originally obtained from the Russians and subsequently expanded through large state investments. These plants mass-produce standardized output of tried and proven design. Lacking engineering experience, they tend not to be highly innovative. Their product quality and production efficiency stand to benefit greatly from the importation of modern process equipment and complete plants.

(b) Medium- to small-scale manufacturing enterprises, under provincial or municipal control. Most of these evolved out of simple workshops or machine shops established in the prewar era of private-sector industrial development in China. They possess a depth of design and engineering experience that makes them much more dynamic and innovative than the large central plants. They enjoy considerable decisionmaking autonomy in upgrading their own technical capabilities and in promoting new-product development within their own regions. But the more important campaigns to diffuse technology across provincial lines are largely directed from the center. The most advanced plants in this group do have access to foreign technology, principally in the form of production equipment and prototypes for adaptation or copying. In short, both of these urban industry subgroups are major end-users of foreign technology, with interests extending across the entire technology spectrum.

Rural industry, technologically the least sophisticated, is entirely locally directed, operating at the level of the county and below. Its output, mostly nonstandardized and of low quality, is mainly aimed at the needs of agriculture -- chemical fertilizers, cement, energy, farm machinery, and implements. The rural production units, of which there are roughly half a million, derive their technological advances solely from a trickle down process of internal diffusion from higher to lower economic administrative levels. Foreign technology has no significant role to play in this process.

In sum, for Chinese industry as a whole, the highly structured process of internal diffusion appears far more important as a source

of technological advancement than the technology acquired from abroad. Foreign technology flows in only to the most advanced plants and activities. Even there, it is often used as much for training and demonstration as for increasing output. The Chinese leadership seems willing to accept some short-run retardation of growth in order to attain in the long run the broader social goals of "mass participation" and "self-reliance."

FORMS OF ACQUISITION

For China today, the more significant forms of foreign technology acquisition are industrial exhibitions, prototype copying, and purchase of complete plants.

Industrial exhibitions, held in China by almost all advanced exporting countries, have proliferated in recent years. Thirty-two such exhibitions have been held since 1971 and six more are scheduled for 1975. Although exhibitors have found these ventures to be high in cost and low in commercial returns, faith in the existence of a "vast China market" nevertheless propels them to demonstrate their best, and to spice their displays with free lessons in technology: educational seminars, films, technical data, and glossy catalogues. For the Chinese, these shows are thus highly attractive. They make their search for relevant foreign technology remarkably easy and offer good opportunities for purchasing display models at favorable prices, for purposes of analysis, "reverse engineering," and copying.

Prototype copying is extensively and effectively practiced by the Chinese, but it has serious limitations. Where the technological gap between originator and copier is great, extracting the technology embodied in a sophisticated design and absorbing it into an unsophisticated industry is often infeasible. Even with considerable assistance from the originator -- his data and his experience -- the copier's task is formidable and time-consuming. But since 1960, the Chinese have systematically rejected such assistance, fearing that it might hamper development of their own creativity. Today, however, the rejection is no longer total. Foreign technicians are once again being admitted,

particularly to supervise erection of complex imported plants. The Chinese now reluctantly recognize that such assistance is often indispensable to the effective absorption of technology.

Importation of complete plants has, in the past three years, become the principal form of technology acquisition. Contracts worth almost $2.5 billion have been let, principally to Japan, France, and West Germany, with plant deliveries extending through 1977. The purchases, however, are centered on only a few industries: petrochemicals, steel, power, and petroleum. Although these are fundamentally important, many other industries are similarly in need of a technology transfusion, including the automotive and aircraft industries, whose present inefficient and obsolescent output could be dramatically improved by the importation of modern production facilities. But negotiations for such plant purchases slowed in the latter part of 1974 and may be held in abeyance, awaiting a clarification of the current international economic disarray.

PROSPECTS

In addition to this economic disarray, three other factors may constrain the further expansion of China's technology import drive: its absorptive capacity, its ability to pay, and its self-reliance principles.

Absorptive capacity -- the ability of a highly skilled technical manpower pool to adapt and assimilate sophisticated technology -- could act as a serious brake on China's progress. It takes decades to develop such a pool, and China's persistent neglect of advanced education in favor of industrial empiricism and the "mass line" is bound to have a cumulative retarding effect.

Ability to pay -- the ability to earn the foreign exchange necessary to pay for imports -- is already a restraining factor. China's current balance-of-payments difficulties may, however, be eased, if not solved, by its favorable prospects for greatly expanded crude oil exports in future years. Such expansion, on the other hand, may itself require large additional technology imports.

Self-reliance principles, finally, continue to impose their ideological inhibitions. If the leadership were to push the liberalizing trend too fast, a political counterreaction and a reversion to a more restrictive technology import policy could result.

CONTENTS

I. INTRODUCTION

As the Cultural Revolution drew to a close in 1969, the PRC's leadership began once again to turn outward and seek capital equipment and "know-how" on a significant scale. By the fall of 1974, what had begun as a modest trickle of orders by the Chinese for machinery and equipment had become a sustained flow. Contracts for complete production plants and huge plant complexes, some valued at as much as a quarter billion dollars, were being concluded on an unprecedented scale, in order to raise output and productivity in a half-dozen basic Chinese industries -- petrochemical, steel, fertilizer, power, petroleum, and mining. A wide range of sophisticated machine tools, of instrumentation, and of production and process equipment was being imported from more than a dozen countries, all vying for the privilege of conducting elaborate exhibitions of their industrial technology in Peking, Shanghai, Tientsin or Shenyang. China's long-standing insistence on paying for its current imports with current exports had clearly softened, and "deferred payment purchase" -- a euphemism for buying on credit -- had become an accepted practice, provided the repayment term was kept short and the interest rate low. Most significant of all, for the first time in more than a dozen years, the PRC was permitting appreciable numbers of foreign technicians to accompany the new plants and remain on sites long enough to monitor proper installation and start-up. Though these technicians were being carefully designated "assistants" rather than "advisers," their admittance represents a substantial easing of past Chinese strictures against a visible role for foreigners.

What should we make of China's renewed pursuit of foreign technology? Is it merely a short-lived shopping spree that will quickly run its course? Or does it portend a new long-term trend away from China's basically autarkic, inner-directed philosophy and toward a development path oriented towards interdependence with the world-economy?

Posing the alternatives in this way seems to imply that the Chinese are faced with a stark choice between autarky and interdependence. Obviously, that is not the case. The choices open to the Chinese leaders are more in the nature of tradeoffs between technical-organizational imperatives (economic values) and Maoist social-revolutionary aims (ideological values). The Chinese leaders must wrestle with the problem of how much productive efficiency and economic growth they should sacrifice for the sake of "creating the new Maoist man" -- molding a highly motivated, disciplined, innovative work force uncontaminated by bourgeois values, economically independent, and technologically self-reliant -- in other words, "liberated from worshipping foreign things"; and prominent in all this is the question of how much the economy should be permitted to rely on foreign technology. As this study will show, Chinese evaluations of these tradeoffs have fluctuated widely, with "ideo-logic" holding sway in periods of revolutionary fervor and "techno-logic" reasserting itself in calmer times. The consequences of these fluctuations are clearly reflected in China's technology acquisition policy.

The term "technology acquisition" is employed in this study in its most comprehensive sense. It encompasses any accretion of capital equipment or technical knowledge, from whatever source, that enhances productivity or reduces costs. Thus it includes both the *tools* (machinery, equipment, and plant) the Chinese must create or import to help them cope with their environment and the *techniques* (skill, know-how, and production processes) they must develop in order to produce or apply these tools.

The study also distinguishes among three kinds of technology: *manufacturing technology* -- most directly related to physical production (skills of fabrication, techniques of processing, refinement of materials); *design technology* -- the realm of science and creativity (research, development, test, and engineering); and *management technology* -- the organizational aspects of large-scale manufacturing (mode of production, worker motivation, occupational stratification, and the structure of authority). As the study will show, Chinese industry has made the most impressive advances in the sphere of

manufacturing technology, has made only modest strides in design technology, and in management technology is still in a rather elementary, exploratory stage. It is undoubtedly in these latter two areas that the Chinese stand to gain most from foreign experience, but they are also the areas in which there is likely to be the strongest Chinese ideological resistance.

The role that this ideological element has played in the evolution of China's technology import policy is considered further in Section II of this Report. Section III examines the several levels and modes of industrial production that now coexist in China, and attempts to assess the proclivity of each to acquire and diffuse technology. A fourth section weighs the merits of some of the more significant vehicles for acquiring technology which the Chinese employ -- industrial exhibitions, prototype-copying, and complete plant imports. A final section briefly discusses key problems the Chinese face in continuing their pursuit of technological advancement.

II. EVOLUTION OF TECHNOLOGY ACQUISITION POLICY

POLICY FLUCTUATIONS AND THE "TWO-LINE" STRUGGLE

How durable is the current resurgence of Chinese interest in foreign technology? Is it merely a brief interlude or does it represent a new long-term trend?

The PRC's behavior in the past provides little support for supposing this a long-term trend. Chinese development over the past twenty years has been marked by sharp oscillations between acceptance and rejection of foreign technology and expertise. In the view of most Sinologists, these oscillations reflect shifting fortunes in the "struggle between the two lines," between the pragmatic, conservative line identified with former Chief of State Liu Shao-chi, and the radical ideological line associated with Chairman Mao. That struggle involves contention over the most fundamental questions of political philosophy and socioeconomic goals, and affects every aspect of policy and program.*

The sharply fluctuating pattern of Chinese economic development and the effects of the ideological struggle on its policy for acquiring technology have already been vividly described by others.** I can therefore confine myself here to giving the briefest of summaries, through the use of a table. Table 1 shows the phases of China's economic development and how these are reflected in its policy for acquiring technology. While a table cannot hope to reveal the scope and

---

*Some Sinologists, however, explicitly reject the "two-line" interpretation. See, for example, the dissenting views of Frederick C. Teiwes, "Chinese Politics 1949-1965: A Changing Mao," in *Current Scene*, Vol. 12, January and February 1974. See also the attempt to develop a more sophisticated "four-line" interpretation by Michel Oksenberg and Steven Goldstein, "The Chinese Political Spectrum," in *Problems of Communism*, Vol. 13, No. 2, March-April 1974, pp. 1-13.

**See, for example, Alexander Eckstein's analysis of the successive phases of Chinese economic development in "Economic Growth and Change in China: A Twenty-Year Perspective," *The China Quarterly*, April-June 1973, especially pp. 238-241; also William W. Whitson's examination of the consequences of these phases for technology policy in "China's Quest for Technology," *Problems of Communism*, Vol. 12, No. 4, July-August 1973, pp. 16-29.

Table 1

CHINA'S DEVELOPMENT PHASES AND TECHNOLOGY-ACQUISITION POLICY (1952-1974)

1952-1957 First Five-Year Plan: "Leaning to One Side"	1958-1960 Great Leap Forward: "Walking on Two Legs"	1961-1965 Great Crisis and Readjustment	1966-1969 Cultural Revolution	1970-1974 Post Cultural Revolution
		Development Phases		
o Maximum rate of fixed capital formation. o Priority for development of basic industry. o Forced draft industrialization; large-scale, centrally planned, integrated plants, Soviet style. o Acceptance of principle of developing local industry serving local needs and utilizing local resources, but more lip service than practice.	o First signs of rejection of Stalinist model of industrialization in favor of Maoist all-out mass mobilization and mass participation. o Proliferation of small-scale inefficient local enterprises with "backyard" technologies. o Nurturing of local initiative and regional self-sufficiency.	o Economic crisis forces shift of priority to agriculture. o Return to Liuist approach: centralized planning and administration by professionals at national and provincial levels; return to economic rationality (uneconomic Great Leap plants closed). o Rural industrialization pushed vigorously.	o Reversion to Maoist principles, pitting masses against technical and managerial elites. o Worship of nativism and renewed pitting of "red" against "expert." o Destruction of party bureaucracy; sporadic economic disruption; some absolute decline in industrial output.	o Return to economic order; new wave of industrial expansion. o Shift in planning and decisionmaking to regional and provincial levels, and further development of decentralized industrial plant in outlying regions. o Use of the more advanced industrial centers to spread industrial systems into hinterland.
		Technology-Acquisition Policy		
o Massive Soviet aid in form of complete plants and industrial systems. Soviet support targeted on heavy industry sector.	o Soviet turnkey projects begin to phase down in face of mounting Sino-Soviet tension and Chinese resistance to foreign expertise. o Sudden withdrawal of Soviet assistance, summer 1960, wreaks havoc.	o Technology import resumes on small scale; a few package plants acquired as prototypes; stress on self-reliance; technology source shifted to Western Europe and Japan.	o Imports of foreign technology drastically curtailed; some plant purchases cancelled; foreign contacts ruptured.	o Return to more vigorous technology import policy; emphasis on complete plants, diversification of sources, greater flexibility on import financing.

subtleties of the issues, it does disclose the linkage between technology and development policies in the abrupt changes that have occurred. Periods of relative receptivity to foreign technology have alternated with periods of determined rejection, and these closely parallel changes in position on larger policy issues.

The Chinese ambivalence on foreign technology can also be illustrated in a more quantitative way by charting the ebb and flow of China's imports of machinery and complete plants in this same period (Fig. 1, p. 7). As the figure shows, these imports peaked in the latter fifties during the era of Soviet tutelage. It was largely that experience which shaped Chinese attitudes toward foreign technology. In that seven-year period, China was the recipient of what was undoubtedly the most comprehensive technology transfer in modern industrial history. The scope and significance of that transfer has not been generally appreciated in the West. At a time when China was weak and isolated, the Soviet Union, hoping to gain hegemony over its new Communist neighbor, provided China with the foundations of a basic industry. The Soviet contribution encompassed much more than production technology. It ran the gamut from scientific and technical education to project design, and from production engineering to creating a modern industrial organization, complete with planning, budgeting, and management systems.

Interestingly, in some areas of manufacturing, the style of the Soviet technology transfer was closely comparable to the United States-to-Japan transfer of the late 1950s and early 1960s.* Both cases involved what might be called interim co-production arrangements under license on a succession of increasingly complex products. In the aircraft industry, for example, as we have shown in the earlier Report (R-1573-ARPA), the transfer progressed from trainers to simple jet fighters to more sophisticated aircraft and helicopters. A gradual

*See G. R. Hall and R. E. Johnson, *Transfer of United States Aerospace Technology to Japan*, The Rand Corporation, P-3875, July 1968, for a detailed examination of this transfer experience involving Lockheed Aircraft Corporation and North American Aviation on the one hand and Mitsubishi Heavy Industries and the Kawasaki Aircraft Company on the other.

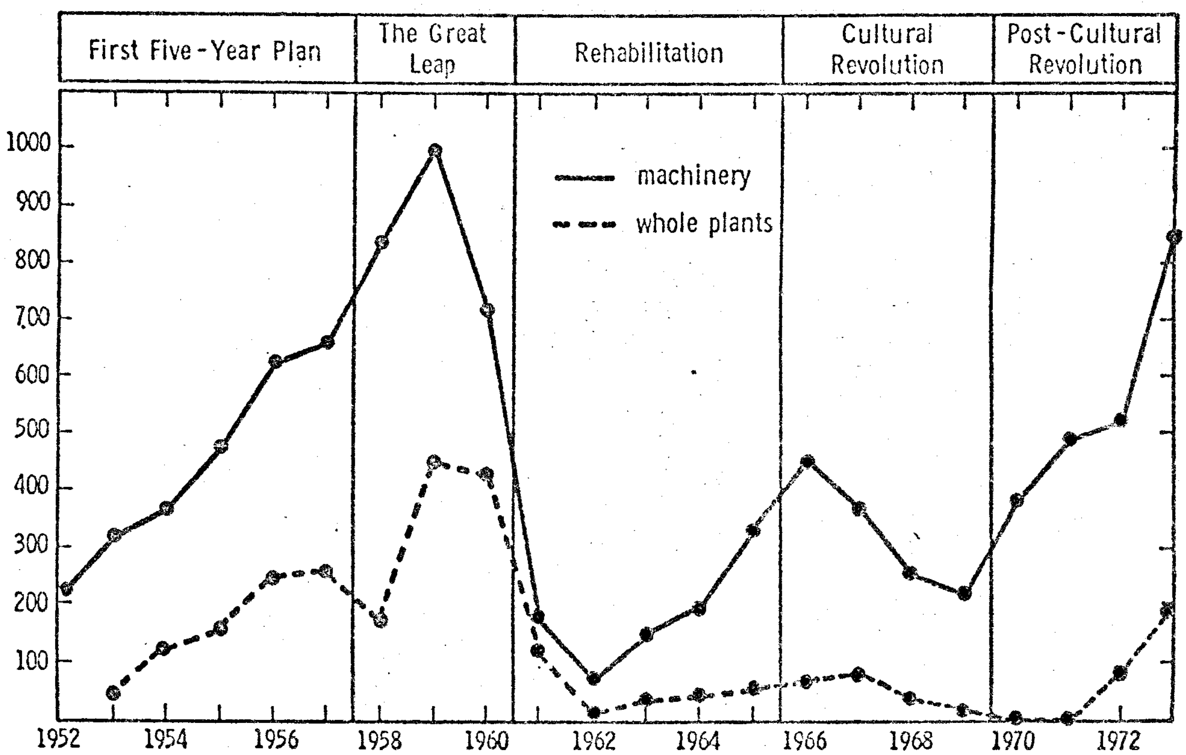

Fig. 1 -- China's imports of machinery and whole plants, 1952-1973
(in millions of U.S. dollars)

Footnotes for Fig. 1 appear on p. 8.

NOTES:

1. Underlying Data

The values reflected in this figure are in undeflated U.S. dollars. The data are intended to represent actual resource transfers (deliveries or disbursements), *not* contracts signed. The figures, in millions of U.S. dollars, are as follows.

Year	Total Machinery & Equipment	Whole Plants	Year	Total Machinery & Equipment	Whole Plants
1952	211	--	1963	136	33
1953	328	48	1964	180	31
1954	380	107	1965	330	45
1955	476	152	1966	455	50
1956	612	230	1967	380	78
1957	645	224	1968	275	20
1958	846	187	1969	240	5
1959	1009	452	1970	395	negligible
1960	742	433	1971	505	negligible
1961	168	156	1972	520	70
1962	59	18	1973	855	190

Current versus Constant Prices. All values shown are in current prices. The inflation factor, however, is significant only for the last four years of the period covered (1970-1973). During those years the prices of China's imports may have climbed by as much as 40-50%. In constant prices, therefore, the increase in the value of China's machinery and whole-plant imports in those years would be far less steep than shown. (See Alexander Eckstein, "China's Economic Growth and Foreign Trade," in *U.S.-China Business Review*, July-August 1974, for a calculation of China's imports and exports in constant prices for 1952-1973.)

2. Sources

Imports of Machinery and Equipment. 1952-1964: Chu-yuang Cheng, *The Machinebuilding Industry in Communist China*, Aldine-Atherton, New York, 1971, pp. 62-64. 1965-1970: Joint Economic Committee, *People's Republic of China: An Economic Assessment (A Compendium of Papers)*, May 18, 1972, p. 353. 1970-1973: *PRC International Trade Handbook*, CIA Research Aid A-73-29, October 1973 and A(ER)74-63, September 1974.

Imports of Whole Plants. 1953-1964: Alexander Eckstein (ed.), *China Trade Prospects and U.S. Policy*, Praeger, New York, 1971, pp. 310-311 and pp. 276-277. 1965-1973: Author's estimates, based on plant purchase data shown in Appendix B.

phase-in procedure was followed in both cases, starting with the simple assembly of "knockdown" airframes, advancing then to component manufacture, and finally to completely indigenous production of the entire aircraft. Although the Chinese were far less advanced technologically than the Japanese of the late 1950s, and therefore far less prepared to absorb the new skills and techniques, they nevertheless made dramatic progress in the seven years of the Sino-Soviet association.

Both the Russians and the Chinese worked hard at the task of transfer and it proved highly effective, although more so in the sphere of manufacturing technology than in design and management technology. But there can be no doubt that, overall, the massive infusion of Soviet capital and know-how was invaluable to China's subsequent development. It would have taken the Chinese decades to evolve such a comprehensive industrial system on their own.*

The large Soviet transfer of capital goods helped the Chinese economy to sustain a high rate of domestic investment in plant and equipment throughout the 1950s. Investment in fixed capital increased fivefold from 1952 to 1959, in conjunction with, or perhaps in consequence of, a parallel quintupling of machinery and equipment imports. As a result, China became heavily dependent on imports for its continued growth. During the 1950s, perhaps as much as one-half of all the machinery and equipment installed in China came from abroad, predominantly from the USSR, but also from the Eastern European socialist countries.

THE BREAK WITH SOVIET TUTELAGE

By the late fifties, it had become clear to the Chinese that the Soviet beneficence was a mixed blessing. Not only had it made them heavily dependent on imports and on Soviet tutelage, it had enticed them into a blind acceptance of the USSR as a prototype for their own industrial development. Moreover, the style of Soviet assistance was

---

*See M. Gardner Clark, *The Development of China's Steel Industry and Soviet Technical Aid*, Cornell University, Ithaca, New York, 1973, especially Chapters 3 and 9 for an excellent assessment of the utility of Soviet assistance.

patronizing and paternalistic. Inevitably, all this evoked a sharp reaction. To save their independence and self-confidence, the Chinese felt compelled to reject that degree of foreign influence. The Great Leap Forward marked the break with dependency and the reaffirmation of a more traditional Chinese nativism and self-assertion. It spurred a great outpouring of sentiment against foreign technology, a pitting of "red" against "expert," and an effort to inspire peasant initiative and stimulate worker innovation. Its aim was to mobilize China's vast human and material resources. It was the first step in what soon became a total rejection not only of Soviet technological guidance, but of the inappropriate forced-industrialization Soviet model, in favor of a more rational "agriculture first" model of China's own creation.

The cataclysmic short-term economic consequences of the Great Leap are well known. Inept policies and gross mismanagement, two successive crop failures, and the precipitous Soviet withdrawal in 1960 combined to bring the Chinese economy, in Eckstein's words, "to a state of prostration similar to that produced by war devastation."* In the early 1960s, domestic investment was cut back sharply and imports of foreign machinery and equipment declined even more, as the Chinese sought to cope with the consequences of their earlier dependency. A policy of self-reliance or import substitution was instituted, and a substantial surplus of export trade had to be maintained for several years, in order to repay the sizable Soviet credits that China had accepted between 1950 and 1957.

By 1965, the economy had largely recovered from its earlier setbacks and both domestic investment and foreign trade, especially machinery imports, were again on the rise, only to be cut back once more by the turmoil and disruptions of the Cultural Revolution. By 1969, therefore, China's machinery imports had dropped to less than one-fourth of the peak levels attained ten years earlier.

---

*See Eckstein, "Economic Growth and Change in China: A Twenty-Year Perspective," *The China Quarterly*, April-June 1973, p. 240.

Since 1970, the Chinese economy has experienced a new wave of expansion, and both imports and exports have risen more rapidly than during any previous period. In the meantime, however, China's GNP has grown very substantially, so that foreign trade now represents only a small fraction of the GNP. It appears that the inward-looking, go-it-alone, boot-straps approach to modernization followed after 1960 has enabled the Chinese to achieve a high degree of technical-economic independence of the outside world. Quantitatively, its reliance on foreign trade is now marginal. China's total imports in 1973 are estimated at $4.5 billion,* which represents, roughly, 2.5 percent of its GNP.**

Moreover, in 1973, imports of machinery and equipment, including complete plants, amounted to $855 million. This represents approximately 6 to 8 percent of China's own machinery and equipment production.*** While all of these numbers are crude, they are not likely to be far enough off the mark to invalidate the observation that, quantitatively, imported technology represents only a very small share of China's overall technology accretion.

Qualitatively, on the other hand, it represents a crucial element in China's economic development, inasmuch as it provides a unique vehicle for gathering knowledge and goods essential to the process of industrialization. The Chinese are likely to continue to import technology, notwithstanding their recurrent injunctions to be "self-reliant."

***U.S.-China Business Review*, Vol. 1, No. 2, March-April 1974, p. 33.

**Arthur Ashbrook ventures a figure of $128 billion for China's GNP in 1971 at 1970 prices. (See Joint Economic Committee, *Compendium*, 1972, p. 47.) Allowing for real growth and dollar price inflation, the 1973 figure might be on the order of $170 billion. A figure of $172 billion, derived from U.S. Government sources, is given in the *U.S.-China Business Review*, op. cit., p. 33.

***Ashbrook estimates China's gross investment at 18 percent of GNP in 1971 (Joint Economic Committee, *Compendium*, 1972, p. 45). Taking net fixed capital formation as 16 percent and the machinery and equipment share as accounting for half of that (based on estimates by Kang Chao for 1952-1965, cited in Robert F. Dernberger, "The Transfer of Technology to China," *Asia Quarterly*, 1974/3, p. 238), one obtains a 1973 machinery and equipment figure of $13.6 billion. A much higher figure is implicit in Chinese statements placing 1971 machinery output at 13 times the 1957 level.

SHADOW AND SUBSTANCE OF "SELF-RELIANCE"

What do the Chinese mean by "self-reliance" and what lies behind the slogan? At first blush, it seems curious that a renewed campaign of exhortation should have been launched in the Chinese press in early 1974, at the very time that China's involvement with foreign technology had moved into high gear. It may clarify matters somewhat if we distinguished among three aspects of policy: broad national strategy, ideological transformation, and resource mobilization.

The aspect relating to broad national strategy has already been touched upon: self-reliance here means avoiding dependence. Humiliated by a century of "unequal treaties" and imperialist encroachments, the Chinese leaders were highly sensitized to any impairment of national dignity. The Sino-Soviet rupture was to them another object lesson in the dangers of foreign dependence. They are determined never again to permit their economy to become strategically vulnerable to a cutoff from any exclusive source of supply. For any important category of goods, therefore, their imports are now widely diversified internationally. The Chinese, after having had to starve themselves in the early 1960s to repay their Soviet credits, are equally determined to avoid any significant financial dependence on foreign countries. Hence their conservative pay-as-you-go trade financing policies. Unlike the vast majority of underdeveloped countries saddled with staggering foreign debt service burdens, China is virtually free of such burdens and now finds itself in an enviably credit-worthy position. In terms of economic strategy, self-reliance has surely paid off.

The policy aspect of ideological transformation is more difficult to assess, partly because issues are expressed in a highly polemical way, and partly because, as has already been indicated (see above, p. 2), decisions involve complex tradeoffs between sociopolitical and economic values. To oversimplify, self-reliance here means building confidence and guarding against alien contamination. It is part of the continuing Maoist revolutionary struggle to transform man into a classless, unselfish, dedicated member of society, confident in his ability to solve the technological problems of development. In the

characteristic "two-line struggle" formulation, the official campaign extols the virtues of Chairman Mao's correct line of

> maintaining independence, keeping the initiative in our own hands, relying on our own efforts and on arduous struggle, and building our country through diligence and frugality,

and it warns against the evil Liu Shao-chi/Lin Piao revisionist line of

> worshipping foreign things, trumpeting the slavish comprador philosophy and promoting the mentality of trailing behind at a snail's pace.*

To be sure, self-reliance is not intended to mean self-sufficiency or complete autarky. Foreign technology may be acquired in the short run so as to reduce the need for such imports in the long run. "The introduction of a bit of foreign technology is permissible . . . [but] we can only use it as reference and must actively catch up with it"; what China is doing, the PRC's Minister of Foreign Trade tells us, is "putting into practice the principle of making foreign things serve China and combining learning with inventing in order to increase her ability to build socialism independently, with her own initiative. . . ."**

"A bit of foreign technology," however, carries with it a bit of foreign presence and the corrupting influence of bourgeois values. Against this, Chinese leaders are vigilant, strictly controlling and limiting the exposure of their people to such influences. The self-isolation and clannishness of Chinese technical groups sent abroad and the circumscribed access permitted to foreign technicians in China are symptomatic of this fear of contamination.

Resource mobilization, finally, is perhaps the most important and least well recognized aspect of the self-reliance policy. The Chinese leaders realize only too well that the needs and desires for advanced

---

*Tien Chih-sung, "Adhere to the Policy of Independence and Self-Reliance," *Jen-min Jih-pao*, Peking, March 22, 1974 (*SCMP*-74-14, No. 5584, April 4, 1974).

**Li Chiang, "New Developments in China's Foreign Trade," *China's Foreign Trade*, No. 1, May 1974.

technology in Chinese industry are almost infinite, simply because the reliability and productivity of most foreign machines are so much greater than those produced at home. But China's ability to import technology is critically constrained by its limited capacity to earn foreign exchange. No foreseeable increase in that capacity could fully satisfy China's potential needs. Undoubtedly a major purpose of the call for self-reliance is to exert ideological pressure and social suasion upon industrial managers to get them to rely as much as possible on the resources of their own enterprises or localities, and thus reduce the clamor for imported technology. The effort to stimulate use of local resources as a substitute for relying on imported resources is not applied only in connection with *foreign* technology. It is aimed equally at all forms of capital allocated from the center, with a view to limiting the demand for such capital. The Chinese press regularly features laudatory reports of factories or workshops that scrap expansion plans requiring costly equipment and large state investments, and yet, at a fraction of the originally projected investment cost, achieve the needed capacity increase through reliance on their own efforts. The purpose of self-reliance in this context, then, is to economize capital and to mobilize local savings, and this aspect of self-reliance has had much to do with the way Chinese industry is structured and how it absorbs and diffuses technology.

III. TECHNOLOGICAL ADVANCEMENT: MODES OF PRODUCTION

To understand better how foreign technology ties into Chinese industry and how technology generally is diffused within industry, we must look more closely at the structure of industrial production that has gradually evolved in China. It is helpful to distinguish among three different modes of production. These are differentiated quite sharply here for purposes of underlining the distinct character of each, although, in fact, categories often overlap or coalesce. The three modes are ranked in descending order of technological sophistication:

1. Scientific laboratory industry
2. Urban industry
   (a) Centrally-controlled large-scale basic and military industry
   (b) Province and municipality-controlled medium-scale industry
3. Rural industry

The modes differ sharply in character and in their need for and access to foreign technology, and it is useful to examine each separately.

SCIENTIFIC LABORATORY INDUSTRY

This stands at the top of the sophistication pyramid. A uniquely Chinese institution, scientific laboratory industry grew out of Mao's insistence that all research be linked to production and out of an educational philosophy that espouses "learning by doing." Hence, purely basic research is restricted to a few vital areas,* and no research at

---

*One such, not surprisingly, is nuclear physics. In that area the Chinese Institute for Atomic Energy Research carries out a wide range of basic investigations in low- and high-energy physics and cosmic radiation. (See the report on the visit of the Max Planck Institute scientists to the Nuclear Research Institute near Peking in *Die Welt*, Hamburg, May 18-19, 1974, Supplement, p. 5.) On the other hand, even in an area

all is officially sanctioned unless clearly aimed at practical results or designed to meet specific, important economic or social needs. Scientific institutes typically couple their research and development activities with manufacturing, through a variety of organizational arrangements. The most common are to set up production workshops within their own institutes, to establish separate pilot plants nearby, or to adopt and reorganize existing neighborhood factories so as to enhance their production competence.* These scientist-guided laboratory-workshops and plants can turn out surprisingly large quantities of sophisticated devices, especially in the field of electronics. For example, the Physics Department of Tsinghua University in Peking manufactures integrated circuits by the thousands; these are produced in the university's laboratory workshop by students and teachers working more or less by hand, but using sophisticated photo-reduction techniques, ultrasonic bonding, and optical systems produced by the Chinese Institute of Optics. The Institute of Electronics of the Academy of Science in Peking, which specializes in millimeter wave and microwave research, manufactures klystrons, traveling-wave tubes, and carcinotrons.** One of the most bizarre examples is that of the Shanghai Institute of Computing Techniques. In 1970, that Institute adopted a neighborhood factory that produced nothing but metallic window-handles with an initial workforce of twenty housewives. The Institute gradually taught this workforce to produce, under quite primitive conditions, magnetic cores, computer mainframes, and transistors. A team of U.S. computer

---

as high priority as agriculture, basic research appears to be almost nonexistent. A team of outstanding U.S. plant scientists that spent a month in China in August-September 1974 was greatly impressed with the effectiveness of agricultural field experimentation and extension service, but found fundamental research in Chinese agricultural colleges and leading research institutes to be in a state of stagnation. (A detailed report on the observations of the U.S. Plant Sciences Delegation in the PRC is scheduled for publication in early 1975.)

*Peking's Tsinghua University has no less than nine factories and 21 workshops of its own. (Peking NCNA, September 15, 1974.)

**Gloria B. Lubkin, "Physics in China," *Physics Today*, December 1972.

experts visited this factory and actually observed assembly work on an integrated circuit digital computer.*

Of course, these workshops and their scientist and institute sponsors are primarily aimed at achieving self-reliance in high technology, and at demonstrating that they can innovate and fashion the equipment and tooling they need without external assistance. Thus, their interests in foreign technology are limited to such things as scientific information, technical literature, scientific exchange visits, and specialized instrumentation. Quantitatively, therefore, they make small claims on foreign technology; qualitatively speaking, however, their connections with the international scientific community are vital.

URBAN INDUSTRY

The next level of the pyramid, urban industry, is the principal claimant for foreign technology. This category consists of two subgroups:

(a) Basic and military industry complexes, vertically and horizontally integrated, Soviet-style. These are in most cases under the direct control of the central ministries. Where not, Peking at least determines their plans and policies. These industries include all of the large metallurgical, machinebuilding, automotive, aircraft, and electronic component plants originally obtained from the Russians but greatly expanded since, as a result of major state investment outlays. They also include largely indigenous Chinese ventures such as the massive petroleum extraction effort in the Taching, Shengli, and Takang oil fields.** The main object of these industries is large-scale, standardized output, and their interest in foreign technology extends to anything that might enhance that output. But innovation policies in these large-scale plants tend to be conservative. The enterprises are relatively young and their skill levels not highly developed. Their

---

*Thomas E. Cheatham, Jr., et al., "Computing in China: A Travel Report," *Science*, October 1973. See also B. O. Szuprowicz, "Computers in Mao's China," *New Scientist*, March 15, 1973.

**This is not to denigrate the valuable assistance, especially in the form of oil drilling and refining equipment, that the Chinese have received at various stages, principally from Romania.

design engineers are still few in number and limited in experience. They are more likely to direct their innovative energy toward gradual product improvement, and marginal innovations in the production line than toward introducing radically new equipment designs or creating novel production flow patterns. These important industries, therefore, stand to benefit greatly from the importation of complete, sophisticated plants with their astonishing economies of scale. The integrated hot and cold steel rolling mills, for example, that are to be built by Japanese and West German consortia at Wuhan over the next three years will not only increase China's steel-rolling capacity by some 25 percent, but will also have a dramatic impact on cost of production and quality of product.

(b) Medium- to small-scale industrial enterprises. These are mostly under the control of the provinces or municipalities and exist side-by-side with the large central plants. They are not only smaller but older than the central plants. Their legacy dates back to the prewar era of private-sector industrial development in China. Most of these enterprises began as simple workshops or machine shops, and moved progressively into specialized repair and overhaul, parts manufacture, and finally production of complete sets of equipment. In the course of this evolution, many of them were merged into larger entities. For example, the Canton Motor Vehicle Plant that manufactures the "Red Guard" 3½-ton truck started out in the early 1960s as the Huang-Pu Machinery Plant, which had been formed by combining a half-dozen small machine and repair shops. These plants are highly dynamic and growth-oriented. They engage in much subcontracting and cooperative new-product development. When it was realized in 1970, for example, that semiconductor production required large numbers of single-crystal furnaces, the Shanghai municipality enlisted twelve factories and institutes in the design and assembly of such furnaces, and reportedly succeeded in getting the first furnace into trial production in thirteen days.* Since many of these provincial and municipal plants

*"China's Young Electronics Industry," *China Reconstructs*, February 1974, p. 8.

serve mostly regional needs, their output is often not standardized, but their operations appear to be far more flexible and innovative than those of the large centrally-directed enterprises. They enjoy the advantage of a far more experienced workforce with a demonstrated ability to copy and adapt foreign technology to their own needs. They are constantly driving themselves, and being driven, to achieve higher levels of technology and to improve the quality of their output and extend its range. Although the provincial and municipal authorities enjoy much autonomy in organizing production and deciding how tasks are to be carried out, it is difficult to believe that the center does not control such critical matters as the determination of priorities and technology diffusion policy, including access to foreign technology.

On this, however, the evidence is sketchy and contradictory. Audrey Donnithorne, in a 1972 article,* emphasized the declining importance of the center and the extent to which provinces, municipalities, and even counties (*hsien*) seemed to be developing along self-sufficient, autonomous lines, under the official injunction "to build small but complete industrial systems by self-reliance." She observed that these entities seemed to be trading with one another on almost mercantilistic principles. She also noted that these local enterprises tended to expand or to create new enterprises out of their own resources, rather than relying on planned coordination by the center and on state investment grants.

It is clear that this kind of autonomous *intra*-province and *intra*-municipality development and diversification has been going on. At the same time, however, an equally important, and more far-reaching process of diffusion has been taking place *across* provincial lines, a process that is very much centrally initiated and state-funded. Often it takes the form of massive nationwide campaigns, such as the "general battle for radio and television equipment" that was launched by the central leadership in 1971. As a result of that campaign every province, municipality, and autonomous region was able within two years to produce its own transistor radios; twenty-six areas achieved at least trial

---

*"China's Cellular Economy: Some Economic Trends Since the Cultural Revolution," *China Quarterly*, October-December 1972, pp. 605ff.

production of television receivers.* Such feats manifestly require both central direction and central resource allocation.

A look at the automotive industry further demonstrates that nationwide diffusion of production technology does not take place solely through autonomous local action. Toward the end of the Cultural Revolution, the regional propagation of truck production became an important state objective. Although provinces and municipalities throughout China organized themselves to manufacture trucks locally, their efforts were thoroughly dependent on the guidance, training, and technology provided to them especially by China's second largest automotive plant, the Nanking Motor Vehicle Plant, which had been selected as a kind of "lead plant." Its popular NJ-130 "Leap Forward" $2\frac{1}{2}$-ton truck was designated as the prototype, and it became the most widely copied truck model throughout China. By 1970, it was possible to identify from Chinese press accounts new manufacturers of this truck in at least nine provinces.** In a more limited way, China's largest automotive plant, the Changchun No. 1 Motor Vehicle Plant in Manchuria, performed a similar function by transferring the technology of its 4-ton and $4\frac{1}{2}$-ton "Liberation" trucks to several other provinces.*** Some recent data on Chinese motor vehicle production† also reveal a fair amount of production interdependence among plants across province lines. For example, engine plants in Shanghai and Hangchow provide the 160-horsepower diesel engine that powers the "Yellow River" 7-ton dump truck made in Tsinan, and the Peking Motor Vehicle Plant that makes the "Long March" 10-ton cross-country truck receives its big diesel engine all the way from Sian

---

*Op. cit., *China Reconstructs*, February 1974, p. 8.

**Wuhan (Hupeh), Nanchang (Kiangsi), Changte (Hunan), Taiyuan (Shansi), Liuchow (Kwangsi), Paotow (Inner Mongolia), Chengchow (Honan), Foochow (Fukien), and Fushun (Liaoning).

By 1972, the first two of these (the Wuhan and the Nanchang plants) had attained a sufficiently high technical level to warrant being listed in the PRC Motor Vehicle Handbook as independent producers of this model truck, each with a brand name of its own.

***Hsining (Tsinghai), Kunming (Yunnan), and Taiyuan (Shansi).

†*Technical Handbook for PRC Motor Vehicles*, August 1972, published by the People's Transportation Agency, Peking (partially translated in *JPRS* 60262, October 12, 1973).

(Szechwan). In short, the image of self-sufficient provincial "cellular" economies is more than a little overdrawn.

To what extent do these provincial and municipal enterprises benefit from foreign technology? As has been indicated, their principal source of new technology is a combination of self-help, improvisation, and a process of proliferation of know-how and exchange of experience within the country. But the most advanced plants also have direct access to technology from abroad, most importantly in the form of technical information and prototypes. This is especially true of plants in such important industrial cities as Shanghai, Peking, Tientsin, Tsinan, Wuhan, and others. For example -- looking again at the automotive industry -- the "Long March" 10- and 12-ton trucks produced by the Hopeh Changcheng Plant in Peking and the "Yellow River" 8-ton truck made at the Tsinan Motor Vehicle Plant are the result of extensive technology assistance provided in the early 1960s by Czech manufacturers (Tatra and Skoda, respectively). The Shanghai Truck Plant, in developing its 15-ton and 32-ton dump trucks, depended heavily on design data and technology obtained from the BELAZ automobile factory in Minsk, and it learned much from a technology license for a French 32-ton truck purchased from Berliet in 1966. Most recently, in January 1974, the Gleason Works of Rochester, New York, obtained an $8.2 million contract for complete sets of sophisticated gear-grinding and axle-producing machinery,* to be custom-built to the needs of six Chinese motor vehicle plants, at least four of which appear to be in the medium- to small-scale category.

In short, both the large-scale central plants and the smaller scale provincial and municipal plants are major end-users of foreign technology. Their interest extends across the entire technology spectrum, as demonstrated by the major products they import: critical materials that lie beyond China's present technical ability to produce (super alloys, special steels, composite materials); high-performance end-products that are urgently needed for the priority tasks of the Chinese

---

U.S.-China Business Review, No. 2, Vol. 1, March-April 1974, p. 10.

economy (earthmoving and off-the-road vehicles for construction, drilling rigs and pipe for offshore oil exploration, dredges for port development, modern trucks and jet airliners for transportation, satellite ground stations for communication; sophisticated equipment obtained as one-of-a-kind or two-of-a-kind prototypes for copying; and, most important, imports of complete plants to boost output in key industries (steel rolling, petrochemical and fertilizer production, power generating, petroleum extracting and coal mining). The PRC's imports in all of these areas have increased significantly in the past several years.

RURAL INDUSTRY

Although technologically the least sophisticated, small-scale local industries are constantly growing and proliferating. They are not centrally planned or controlled, but rather are directed or coordinated almost entirely at the level of the county. They generally fulfill three conditions: they use raw materials which are locally available, they manufacture locally, and their products are, in the main, distributed locally. Their output, mostly nonstandardized and of low quality, is principally aimed at serving the needs of agriculture within their own regions. The small-scale plants located near big urban centers are a major exception. They are more likely to be tied into the urban industrial system, which may provide them with materials and with markets for their products. Hence these suburban or exurban local plants tend to be technically more advanced than the purely rural units. Rural units, of which there may be as many as half a million, fall basically into five closely complementary categories: energy (hydroelectric power and coal), cement, chemical fertilizers, iron and steel, and machine-building. Collectively, they now produce enough to fill a large share of China's total agricultural needs.*

---

*According to published CIA estimates, small plants currently contribute more than 50 percent (by weight) of nitrogenous and 75 percent (by weight) of phosphate fertilizers. They also provide almost all of the simple agricultural tools and enough cement to meet practically all local needs. (See *China: Role of Small Plants in Economic Development*, Central Intelligence Agency, Research Aid, A[ER]74-60, May 1974, p. 1.)

These local industries derive their technological advances solely from a trickle down process of internal diffusion from higher to lower economic-administrative levels -- from province to county, county to commune, commune to production brigade, etc., with each higher level providing technical guidance, training, and equipment to the lower levels. The diffusion process is aided by a local technology system that includes a "mass scientific network" (an agricultural extension service), formalized local problem-solving groups, and "farm machinery research institutes," which carry out trial manufacture and popularization work.

At a higher level, the diffusion process is often highly organized and complex. For example, in 1970, Shanghai was assigned the task of designing and producing reasonably efficient standardized packages of equipment for small-scale rural synthetic ammonia production. It took two years, 10,000 people, a network of 400 plants in the Shanghai area, and a tremendous coordination effort, to turn out enough machinery, instruments, and gauges to furnish 300 sets of such equipment packages.* By now, many other provinces have acquired this kind of management-coordination technique. Rural industries are increasingly drawn into the network to supply the simpler components. These lower echelon industries have a strong incentive to upgrade their technical competence. Greater proficiency enables them to mesh with the production processes used at parallel and higher levels, and thus to raise the acceptability and profitability of their output.

In rural industry, technology acquisition is entirely an internal process. It encompasses rural mobilization, basic technical education, and on-the-job development of skills. It is a process of diffusing technology vertically and horizontally and of engendering mass participation and mass initiative. Foreign technology has no significant role to play in this process.

Looking at all three modes of industrial production in China, the highly structured process of internal diffusion appears far more

---

*See Jon Sigurdson, "Rural Industry and the Internal Transfer of Technology in China" (paper presented at University of Sussex Workshop, June 1974), for an excellent discussion of this experience.

important as a source of technological advancement than the technology acquired from abroad. Foreign technology flows in only for industries at the top half of the pyramid, to the most advanced plants and activities. Even there new equipment, processes, and techniques are often used as much for training, education, and demonstration, as for increasing output. Western visitors to Chinese factories frequently comment on the astonishingly high labor/capital ratio, the large number of seemingly redundant workers milling around the machinery. While they recognize that this can be partly explained by the relative labor abundance and consequently low real wage costs in the Chinese economy, they are often unaware that there is also a large amount of in-plant training and "advanced experience sharing" that is continually carried on. Evidently, the Chinese leadership is willing to accept the cost of some temporary decrease in productivity, some short run retardation of growth, in order to attain in the long run the broader social goals of "mass participation" and "self-reliance."

IV. TECHNOLOGICAL ADVANCEMENT: FORMS OF ACQUISITION

To analyze more particularly the significance of the contribution foreign technology makes, or could make, to Chinese development, we shall consider separately three of the more significant forms of acquisition: industrial exhibitions, procurement of "prototypes" for learning and copying, and purchase of complete production plant and process equipment.

EDUCATION BY EXHIBITION

A seemingly popular, but little-publicized vehicle of technology transfer to China is the industrial fair or technological exhibition. These seem popular, for almost every one of the more industrialized countries of the world has held or is planning at least one such exhibition in China. But they receive little publicity, because each exhibition is treated as only a minor commercial event in the country that stages it. Accordingly, outside of a narrow circle of China traders, there is little appreciation of the scope of these exhibitions, or of the astuteness with which the Chinese exploit the opportunities they offer.

Curiously, for the exhibiting countries, conducting industrial fairs in China is not a particularly attractive proposition. The logistics are formidable and require as long as two years' preparation. The costs, both in money and executive time, are high -- close to two million dollars for the 1972 Canadian fair, $1.5 million for the 1973 British fair, and a similar sum for the Australian display held in October 1974 -- and the commercial rewards to the individual firms are usually negligible, limited for the most part to discounted sales of the display models at the end of the show. And yet, country after country is willing to make the trek, so intense is the competition for export sales, so abiding the faith in the existence of a "vast China market," and so tempting the opportunity the exhibition offers to penetrate behind the Chinese trade

corporations and meet face-to-face the industrial end-user who makes the critical purchase selections.

The striking record of technology exhibitions held in China in recent years is shown in Table 2. A few such exhibitions were held in the 1960s, until they were stopped by the antiforeign campaign of the Cultural Revolution.* Since 1971, however, they have proliferated. By the end of 1974, no less than 32 will have been held, with six more planned for 1975.

While the table gives some impression of the variety of these exhibitions, it does not reflect their highly advanced technological quality or the fact that, largely in response to Chinese urgings, they are educational, rather than commercial in character. These aspects emerge more clearly from the tabulation in Appendix A, which provides a more detailed description of the exhibitions held and planned.

Some highlights are worth noting:

- The exhibitors tend to be the most prestigious and they show the latest and most advanced technology the countries have to offer in fields of particular interest to the Chinese, often including devices never demonstrated previously anywhere.
- Some exhibits are shown in more than one city.
- The exhibits typically feature hundreds of technical seminars and industrial films, backed up by demonstrations and displays.
- Great quantities of technical data and glossy catalogues, specially printed in Chinese, are made freely available.
- Visitors are selected by the Chinese, usually by invitation only, and appear to be largely composed of highly qualified specialists from major manufacturing and research centers.

---

*A Swedish exhibition that was about to open in early 1967 was cancelled when the ship carrying its exhibits was actually turned back when it steamed into Shanghai harbor.

Table 2

FOREIGN INDUSTRIAL EXHIBITIONS IN CHINA, 1971-1975

Year	Exhibitions by Year, Type, Exhibitor, and Site				Exhibitions by Year, Site, and Number	
	National Exhibitions		Specialized Exhibitions			
	Exhibitor	Site	Exhibitor and Type of Exhibition	Site	Site	Number
1971	Romania	Peking	Hungary: Medical instruments, medicine	Peking	Peking	3
	Yugoslavia	Peking				
1972	Denmark	Peking	Japan: Electronic measuring instruments	Tientsin	Peking	6
	Sweden	Peking	Bulgaria: Medicine	Peking	Shanghai	1
	Canada	Peking	Japan: Machine tools	Shanghai	Tientsin	3
	Italy	Peking	Construction machinery	Tientsin	Peking & Shanghai	1
	France	Peking & Shanghai	Hungary: Machinery, vehicles	Tientsin		
			Poland: Construction & mining equipment, engines	Peking		
1973	UK	Peking	Norway: Gas turbines, industrial electronics	Peking	Peking	5
	Netherlands	Peking	East Germany: Machine tools	Shanghai	Shanghai	1
			Japan: Electronic & medical equipment	Peking		
			France: Measuring & scient. instruments	Peking		
1974	Austria	Peking	Hungary: Electrical instruments	Peking	Peking	7
	France	Peking	Canada: Electronics, scient. equipment	Shanghai	Shanghai	1
	Mexico	Peking	Switzerland: Machine tools, watches	Peking	Tientsin	2
	Australia	Peking	Denmark: Electronics, medical instruments	Shanghai & Peking	Shenyang	1
	Romania	(a)	Poland: Mining equipment	Tientsin	Peking & Shanghai	1
			Japan: Agricultural machinery, fertilizers	Peking		
			Printing & packaging	Tientsin		
			East Germany: Agricultural machinery	Shenyang		
1975	Belgium[b]	Peking	UK: Machine tools, scient. instruments	Shanghai	Peking	5
	W. Germany	Peking	Hungary:[b] Machinery, vehicles	Peking	Shanghai	1
	Argentina[b]	Peking	East Germany:[b]	(a)		
	Japan[b]	Peking			Total	38

[a]Not known.

[b]Planned for 1975.

In short, the exhibitions make the search for relevant foreign technology remarkably easy for the Chinese. They are treated, at virtually no cost to themselves, to a perpetual high-level technical symposium, in which executives of leading international firms act as teachers and demonstrators, and Chinese technicians as students and referees. Just how well they are able to absorb the lessons, and how sound their purchase decisions are, is difficult to assess. Only a few things can be learned from looking at a display model, hearing it described, and reading a technical sales brochure. Buying the model for the purpose of analysis and "reverse engineering" is obviously far more rewarding. The industrial fairs offer good opportunities for purchasing such models at bargain-basement prices, since exhibitors see selling them as a foot in the door to the China trade and would also prefer to avoid paying the return freight for their exhibits. But prototype copying has its limitations.

PROTOTYPE COPYING

The procurement of a wide variety of one- and two-of-a-kind prototypes is a form of acquisition which the Chinese have developed into something of an art form. In addition to purchasing display models at trade fairs, the Chinese have opportunities to locate appropriate technology when their technical missions are taken on plant visits abroad. In recent years, a great number of such missions have been roving the world, similarly gathering free lessons in technology. In nine months of 1973, no less than 53 Chinese technical teams visited Japan alone.*

Recorded instances of successful Chinese prototype copying, done without any outside assistance, are legion. The Massey-Ferguson 35 hp tractor is one of the earliest examples, and the Hasselblad 500 C/M camera one of the most recent. Copying need not, of course, take the form of completely reproducing an item. The Chinese often purchase a piece of modern equipment, such as a more advanced Massey-Ferguson tractor, because of their interest in only one element, for example, an

***China Trade Report*, September 1973, No. 322.

improved transmission, which they then proceed to copy. Selective technical upgrading of this sort is apparently done on a large scale.

But prototype copying also has serious limitations. First, the prototype to be copied must be at the right level of sophistication -- with respect to design engineering, fabricating skill, machining precision, and materials applications -- relative to the competence the Chinese themselves have attained. If the item is too advanced, reverse engineering becomes too difficult. Even the relatively simple matter of hand-fashioning or custom-building a single duplicate is arduous enough. Without access to the design and manufacturing data, the copier must recreate the basic blueprints, the detailed engineering drawings, and, most important, the materials specifications. Devising adequate materials specifications often requires sophisticated metallurgical analysis, testing, and experimentation. The follow-up problem is equally difficult -- the level of fabricating technique attained by the copier may not be adequate to duplicate the metal-casting, forming, shaping, joining, and finishing operations required to achieve the necessary endurances, tolerances, and dimensional accuracies.

The task becomes even more trying when the objective is not merely to fashion a single duplicate, but to achieve a series production run. Large-scale production is ultimately the touchstone of manufacturing efficiency. Hand-fashioning, custom-building, and batch-type production are still typical of much industrial production in China, and given the multisector nature of the Chinese economy -- with modern, intermediate, and primitive technologies existing side by side -- these small-scale, labor-intensive techniques will no doubt continue in use for many years. But for the modern, capital-intensive sector, acquisition of efficient, high-volume production methods and advanced management technology is indispensable.

Moving into large-scale production imposes the additional requirement of design standardization to achieve perfect interchangeability of parts and components; it also involves production tooling, plant layout, materials and work scheduling, and quality control. Again, without assistance from the originator, the copier's task is formidable and

time-consuming. The prototype reveals only *what* was produced; it does not reveal *how* it was produced.

And that raises the second major limitation: when the copier has finally succeeded in series-manufacturing the item, he has merely demonstrated that, given time and effort, he can slavishly copy an existing design. He has not significantly enhanced his ability to design on his own. The prototype does not explain the rationale behind the original designer's choices. Every major design feature of a complex, modern piece of equipment is the outcome of a large number of engineering compromises and tradeoffs, the results of stress calculations, laboratory experiments, and functional tests. "Understanding" the design to the point that the copier can ultimately improve upon it means knowing *why* these compromises were made and *how* the tradeoffs were arrived at. The copier cannot learn this from studying the finished prototype. He must essentially retrace or reproduce the original designer's calculations and investigations. This is relatively easy if the copier is willing and able to obtain the original designer's assistance -- his data and his experience. But the Chinese have systematically rejected such assistance throughout the post-Soviet period, rendering their problem far more difficult. Just how difficult will depend largely on the level of design experience and production know-how that the copier already possesses, i.e., the size of the technological gap that separates him from the originator.

The Chinese leaders are not unaware of these limitations. While they have sanctioned copying on a considerable scale and will no doubt continue to do so, they warn that excessive reliance on this form of acquisition would condemn China's technical level to permanent inferiority, ". . . because others are continuously advancing. . . . Purchasing sample machines from others can only be for the purpose of increasing our knowledge and knowing how others have taken their road. We cannot open up a road for ourselves merely by copying from others."* The Japanese are no doubt the past masters at finding the right combination of copying

*Shen Hung, *Kuang-ming Jih-pao*, April 8, 1965 (*SCMP*, No. 3441).

the designs of others and originating their own, and the proper evolutionary sequence in moving from one to the other. The Chinese seem to suffer by comparison, having both stronger ideological inhibitions against unrestricted copying and a weaker thrust toward developing design originality.

IMPORTATION OF COMPLETE PLANTS

Some of China's shortcomings in design and management technology may be gradually eased by another form of technology import, the turnkey production plant or comprehensive equipment package, complete with the technical data and advisory assistance to set it up. The Chinese resorted to this form of acquisition only on a modest scale in the post-Soviet period of the 1960s. The idea then was to set up such plants as models of ultramodern production technology which the Chinese would subsequently attempt to replicate. For example, in 1963 the Chinese purchased a 175,000-ton per year urea plant from The Netherlands. It was set up in Luchou (Szechwan) with Dutch technical assistance, with the express intention of having the Chinese build a duplicate on the spot. They hoped that by such a model-plant copying process they would be able to build up their own modern fertilizer production capacity to some twenty million tons within ten years. The copying effort, however, turned out to be far more difficult technologically than they had expected, and the Chinese never did succeed in building a plant of anything like the capacity of the Luchou enterprise.

Because of difficulties encountered in the 1960s, and because of the urgency of improving and expanding production in some key industries, the Chinese have shifted to a different strategy. They have now begun to import not a scattering of model plants, but entire industrial complexes, in some cases on a massive scale. Thus, since the Cultural Revolution, and especially in the past two years, the Chinese have entered an entirely new phase in their plant purchases. Table 3 gives an approximate breakdown of these purchases by type of plant and by country of origin. The purchases shown cover the period from January 1972 through September 1974 and represent contracts concluded, *not* plants delivered.

Table 3

PRC PURCHASES OF COMPLETE PLANTS
(Contracts concluded January 1972 through February 1975)

By Type of Plant

Type of Plant	No. of Units	Estimated Cost (Million US$)
Iron and Steel Plants		635
Rolling mills	5	
Iron works	1	
Power-Generating Plants		303
Complete stations	3	
Turbines and generators	46	
Petroleum Exploration and Extraction Plants		127
Offshore drilling platforms	4	
Oil rigs	2	
Survey and supply vessels	33	
Petrochemical and Synthetic Fiber Plants		900
Intermediate product	33	
Synthetic fiber	11	
Chemical Fertilizer Plants		534[a]
Ammonia	17	
Urea	15	
Other Plants		133
Total		*2,632*

By Country of Origin

Country	Cost (Million US$)	Share (%)
Japan	1,190	45
France	557	21
West Germany	405	15
United States	208	8
Italy	103	4
Netherlands	90	4
USSR	25	1
United Kingdom	25	1
Denmark	20	1
Belgium	5	Negligible
Sweden	4	Negligible
Total	*2,632*	*100*

SOURCE: For details of sources and methods, see Appendix B, pp. 48-50.

[a]Excludes value of four 1972 Japanese fertilizer plants for which no cost data are available; actual total, thus, may be some $50-60 million higher.

Actual deliveries will be spread over a period of several years (in some cases as many as four years). Because the estimates are based on incomplete and often contradictory press and trade publication reports, they must be treated with some reserve.* Nevertheless, the table provides a fair indication of the major thrust of the plant acquisitions. They are centered on a few basic areas which are necessary for China's growth and for feeding and clothing its people: the industrial fundamentals of steel, power, and petroleum, and the all-important petrochemical industry -- chemical fertilizers for agriculture, man-made fibers for the textile industry, and petroleum-based plastics for numerous purposes. All of the plants to be delivered are ultramodern and represent high-technology production equipment. In the few branches of industry they affect, the plants will enable China to "leap forward" in production efficiency and product quality.

The plant purchases, however, are not nearly broad enough. Many other branches of industry are equally in need of a technology transfusion, and appropriate plant acquisition could make a big difference. The automotive and aircraft industries are two cases in point.

In the automotive industry, as a forthcoming Report (R-1574-ARPA) indicates, China has only two reasonably large-scale production plants -- Changchun and Nanking. These two produce at least two-thirds of the roughly 120,000 trucks China turns out annually. But the models they produce are ancient. They are replicas of the thirty-year-old ZIS-150 and GAZ-51 models the Chinese inherited from parent plants in Moscow and Gorki through Soviet technology assistance in the mid-fifties. The Soviet models, in turn, were copies of trucks that the United States had provided the Russians under Lend Lease in World War II. They are functional, of course, but grossly deficient in productivity, maintainability, and durability.**

---

*See Appendix B for a complete listing of plants purchased.

**These deficiencies are reflected both in the performance indicators derived from Chinese truck specifications (compression ratios, fuel consumption, ratios of weight to horsepower, etc.) and in the observations of Western automotive experts who have toured Chinese plants.

Interestingly, among the large number -- at least three dozen -- of small-scale provincial truck plants described earlier the most advanced are able to manufacture trucks that are considerably more modern, with overhead valve gasoline engines and with higher compression diesels. However, these plants are amalgamations and mergers of small workshops or municipal repair shops, and thus cannot produce in significant volume (i.e., volume larger than a few thousand trucks per year).

The Chinese are keenly aware of their problem. They have been importing trucks in large numbers and in a variety of models from more than a dozen countries, but especially from France, Italy, Romania, Germany, and Japan. In 1973, they imported a record 16,000 from Japan alone, declining to a more normal 3,600 in 1974. This widely scattered importation is very costly, and the great diversity of models creates a nightmarish problem of maintenance, logistics, and spare parts supply. Moreover, to meet its massive needs for transportation and construction, China requires a much larger fleet of more capacious and efficient heavy vehicles. Importing a modern production plant would offer a relatively quick solution. Indeed, the Chinese for some time now have been negotiating with Toyota for the possible purchase of a \$380 million integrated automotive plant, and with Volkswagen for the acquisition of a plant to manufacture the VW Safari jeep. These acquisitions would constitute a tremendous jump in production and management technologies for the Chinese -- at least as great as, if not greater than, the change in the Soviet automotive industry that followed the comparable Fiat-Togliatti plant transfer to the Soviet Union a few years ago. But it is not at all clear that the Chinese are as yet ready to make such comprehensive plant purchases in the automotive industry. For the moment, they seem to be limiting their purchases to specialized machinery and technology licenses that will selectively improve their ability to manufacture major components -- such as roller and shell bearings, clutch and brake linings, fuel pumps and injectors -- rather than seeking to modernize their entire industry in a more dramatic way.

What the Chinese lack is not the ability to manufacture. They manage quite well with custom-building, hand-machining, and small-scale

batch-type production. What they have not mastered are the techniques of modern continuous-flow production processes, precise automation technology, and other organizational aspects of management technology. It is in these areas that package plant imports can be most helpful. The imports carry with them not only novel production systems and fabricating techniques, but also efficient plant layouts, flow patterns, embodied production organizations, and implicit management systems.

The aircraft industry is a second example of the potential value of such imports. In China, this industry is oriented almost entirely toward military production, but has not enjoyed a very high priority compared to certain other military industries. In the military sphere, the Chinese leadership has concentrated for many years on a rather narrow set of priorities.* These priorities might be reduced, somewhat too simply, to just three: nuclear weapons, rocket propulsion, and electronics -- all self-evidently related. This concentration has meant that China was allowed to fall far behind in many other areas of military production. Aero-engines are a good example. China worked hard on airbreathing propulsion during the late 1950s and early 1960s, but the higher priority rocket propulsion field subsequently drew away some of the best scientists, engineers, and other scarce resources, leaving aero-engine technology in a state of retarded development. As a result, a big gap now separates China's aero-engine design and production capabilities (exemplified by the mid-fifties generation turbojets in their inherited, Soviet-designed fighters and medium bombers) from the sophisticated current generation turbofans of Rolls Royce, Pratt & Whitney, and General Electric that power the major Western aircraft. Western aeronautical experts report that the Chinese themselves judge their aero-engine technology to be at least twenty years behind the West. Our own comparison of Chinese and Western turbine engines, in terms of the

---

*The narrowness of this concentration was already apparent in the 1950s. It is exemplified by the seven highest-priority fields of research singled out among the 57 "important tasks" listed in the Twelve-Year Science Plan (1955-1967) adopted in mid-1956: atomic energy, semiconductors, electronics, computer science, automation, high-speed fluids, and turbine propulsion (Keiji Yamada, "The Development of Science and Technology in China: 1949-1965," *The Developing Economies*, Vol. 9, No. 4, December 1971, p. 518).

most relevant performance criteria, tends to support that judgment.*
Such a substantial gap cannot be overcome by independent, incremental upgrading or by importing some advanced engines as prototypes for copying.

As in the automotive industry, large advances can only come through direct technological assistance from abroad. Indeed, the Chinese have been negotiating with Rolls Royce (1971) Ltd. to acquire licenses for unrestricted production rights for Rolls Royce Spey engines, complete with extensive technical assistance from Rolls Royce engineers. Acquiring that technology would in relatively short order bring the Chinese ten years forward into the more advanced turbofan era of the early sixties. Accomplishing such a leap would require a considerable Chinese domestic investment effort in training and facilities and a gestation period of two or three years. Thus it would still leave the Chinese at least a dozen years behind the most advanced turbofans now operational in the West. Nevertheless, the practical consequences of the ten-year jump would mean a significant advance for their future aircraft performance. The relationship with Rolls Royce, moreover, could be developed into a longer-term association, encompassing progressively more advanced levels of technology. In this way, the momentum of the effort would continue beyond the initial jump, and China's independent design and manufacturing capabilities would grow apace. This, however, would require a continuation of the present liberalizing trend in the Chinese leadership's interpretation of the "self-reliance" principle.

---

*See Part I of this series of reports (R-1573, pp. 57-61).

V. PROBLEMS AND PROSPECTS

From what has been described, it should be clear that China's potential economic gains from foreign technology are large and that its appetite for importing technology is growing. Not only has there been a great spurt in the numbers of technology imports; almost every day brings new reports of Chinese feelers, explorations, and contract discussions over an ever-widening range of technologies and processes. In the first eight months of 1974, China concluded contracts for complete plants worth almost $750 million. Since that time, there has been a visible slowdown in contract closings, which may simply reflect a pause in the PRC's purchasing cycle, or some hesitation in the face of the current international economic disarray. The pause, however, is unlikely to be prolonged. The modernization drive is almost bound to continue on its own momentum.

The typical Chinese enterprise remains small; coal, power, iron and steel, machinery and all forms of transportation equipment are produced in relatively small-scale, only partially modernized units whose output is uneven in quality. Now that the leadership has recognized the economic efficiency of large-scale undertakings and is moving seriously into advanced plant and equipment in some branches of heavy industry, the expansion of other branches must inevitably follow. Such a drastic change in the character of industrial production cannot be undertaken from the country's own resources alone. China must increasingly look abroad for assistance.

The task, however, is beset with problems. Three of these deserve brief comment.

One is simply the problem of *absorptive capacity* -- but used here not in the usual sense of the ability fully to employ labor, but in the sense of the ability to absorb sophisticated capital. It is most critically a question of how to develop the higher echelons of skilled labor, design and production engineers, technicians and supervisory personnel so essential to setting up and operating a modern plant. Thousands of skilled workers will shortly be needed, as the bulk of the recently ordered

plants come on stream in the next three years.* To assess here the extent of the shortage of such workers is not easy. It might be argued that China experienced no serious problem of absorptive capacity during the 1950s, when the rate of technology transfer (primarily from the Soviet Union) was considerably larger in real terms than it is now, and when China's technical manpower resources were far smaller.** In the 1950s, however, the Soviet transfer of plant and equipment was accompanied by a vast transfer of human skills and educational services, for which there is no parallel today. Moreover, although China's policies of stressing industrial empiricism and mass education are effective in proliferating lower and mid-level skills, they are bound to affect the quality of advanced training. The conscious emphasis, especially since the Cultural Revolution, on practical experience, on "learning by doing," the closing of universities for several years, and the proletarianizing reforms of tertiary education (e.g., reducing admission standards, shortening the curriculum) could not help but retard the development of a technical labor force with skills and educational standards comparable to those of the Western world. It takes decades to develop such a force, and a present deficiency could well act as a serious brake on China's rate of technological modernization. There is no indication that the post-Cultural Revolution educational reforms have begun to come to grips with this problem.***

A second problem that might constrain the expansion of China's technology import drive is *ability to pay* -- ability to expand exports so as to earn the foreign exchange necessary to pay for imports. The Chinese have kept a close watch on the rate of inflation in the world market and adjusted their export prices sharply upward in 1973 to take

---

*Some $800 million worth of plant are scheduled to be delivered during 1976, and some $1 billion during 1977. (For details, see Appendix B.)

**Technical manpower in China is estimated to have increased from two million in 1952 to 7.3 million in 1971. See J. P. Emerson, "Administrative and Technical Manpower in the PRC," *International Population Reports*, Series P-95, No. 72, April 1973, p. 37.

***See Frederick C. Teiwes, "Before and After the Cultural Revolution," *The China Quarterly*, April-May 1974, pp. 332ff.

full advantage of the new market conditions. But though they have greatly enlarged their range of exportable light industry manufactures, they are beset with materials shortages, capacity limitations, and transportation bottlenecks which will limit the rate at which exports can be expanded. At the same time, they are now really feeling the consequences of the world economic recession, in the form of a fall-off in demand for China's most important exports, such as textiles and light industrial products. Moreover, the relentless growth of China's population, no matter how successfully restrained, will continue for the foreseeable future, to require China to import large quantities of cereals, fertilizers, and other food-related raw products, imposing a persistent drain on its foreign exchange resources.*

In part, the Chinese have eased their problem by modifying their long-standing conservative payments policies. They have been willing to incur large trade deficits with some countries (notably a gaping deficit with the United States), and cover these by surpluses achieved with others (notably the less-developed countries of East Europe and Asia). Also, they have been willing to accept "deferred payment" and "progress payment" terms, governmentally subsidized credit, and other schemes for low-interest borrowing.** They have been receiving every encouragement in this direction from the international financial community, especially from the Japanese. The latter have, for example, provided China with a large trade credit by opening a yuan account in the Bank of Japan and allowing China's yuan reserves to build up to as much as $1 billion, while holding down Japan's yen reserves in the Bank of China to less than $50 million.

In the longer run, however, China's export earnings will have to grow substantially if its imports are to continue to expand. A dramatic

---

*For 1974, China appears to have incurred its first significant balance of payments deficit, amounting to perhaps $700-$800 million.

**More than half of the plant purchases to date have been made on "deferred payment" terms -- typically a 20 percent down payment with the balance being paid off in semi-annual payments over a five-year period after the plant is completed; a 6 percent per annum interest charge is included in the purchase price.

solution seems to be in sight: China's petroleum resources may well turn out to be the key to China's hard currency earning problem.

Thanks to an auspicious, if not prescient, energy investment policy that has for many years favored oil over coal, China finds itself now in the enviable position of being able to expand petroleum production drastically. Its vast proven onshore reserves and a vigorous extraction effort have enabled China to increase the value of its exportable crude oil surpluses tenfold between 1973 and 1974 and to hold out the prospect to Japan of being able to supply it with as much as 35-50 million tons of liquid fuel by 1980. At anything like current oil prices, that kind of export bonanza would surely help avoid future foreign exchange earning crunches. At the same time, it implies a rate of expansion of output that may not be achievable without assistance from abroad. The Chinese have demonstrated a remarkable ability to develop their onshore fields on their own, but a tripling or quadrupling of output over the next six years, as is apparently intended, would require not only very large quantities of high technology for exploration, extraction, and refining, but also a huge investment in transportation, including pipelines, barges, tankers, harbor improvements, and offshore loading facilities. The transportation problem could be eased if the Chinese shifted to offshore drilling, but this would require even more complex technology, and would almost certainly necessitate substantial resort to foreign expertise. There is an obvious circularity here: to expand technology imports, China must increase its exports: to expand exports, China must increase its technology imports!

A solution would be for China to enter into joint ventures or contingent service contracts with international petroleum exploration and drilling firms. The Chinese, however, have repeatedly and firmly rejected such a course. They evidently recognize that this would aggravate the third problem -- the need for the Chinese to preserve at least something of their self-image of self-reliance.

A concluding word about this third problem:

To some Chinese, the intrusion of foreign influences must loom once again as a threat. With large-scale influxes of Western visitors, greater exposure of Chinese technicians and functionaries to capitalist ways

abroad, reacceptance of the relevance of foreign expertise and technology to Chinese development, and the noticeable revival of the pragmatic Liuist line, the Maoists must be deeply disquieted as they seek to preserve the purity of the revolution. In the tradeoff between ideo-logic and techno-logic, the trend of the last two years has been a steady and highly visible drift away from self-reliance and past policies of avoiding dependence, toward a more open, flexible relationship with the outside world. The Maoists can see this only as a threat of backsliding into revisionism.

The recent anti-Confucious-Lin Piao campaign is a reminder that the "struggle between the two lines" continues; and our earliest chart (see Fig. 1 above) tells us that trends in technology policy can be reversed. For the moment the xenophobic aspect of the campaign, the criticism of foreign things, has died down, and the emphasis is on party unity rather than on mass agitation. The existing policy seems firmly established, and current indications are that it will not be reversed. But who can be sure? The leadership must no doubt tread gingerly and avoid pushing the liberalizing trend too fast, lest what has been an educational campaign of purification turn into a purgative one. In shaping future technology policy, the leadership must view this danger both as a dilemma and a constraint.

Appendix A

FOREIGN INDUSTRIAL EXHIBITIONS IN CHINA, 1971-MARCH 1975
(By country, date, type, and location)

Country, Date, (No. of Days)	National or Specialized	Products and Equipment Exhibited	Location	% of Display Sold	Attendance	No. of Firms
Austria Mar-Apr 1974 (14)	National	Industrial: steel, electrical machinery, & chemicals. Austrian technicians held seminars attended by hundreds of Chinese technicians. (Largest Austrian exhibition ever held abroad.)	Peking	---	120,000	74
Australia Oct 1974 (13)	National	Agricultural implements and methods, pedigreed livestock ($325,000 worth given to PRC); communications & transport equipment (including full-scale mock-up of NOMAD aircraft); mining equipment & development. Industrial raw materials, banking services. Equipment worth $2.0 million was on display. Firms presented technical papers with lectures by experts in specific fields, discussion groups with Chinese engineers/technicians, seminars & technical films. Estimated cost: $1.5 million (largest & most complex Australian exhibition ever staged abroad).	Peking	---	170,000	100
Argentina 1975 (Planned)	National	---	Peking	---	---	---
Belgium Spring 1975 (Planned)	National	---	Peking	---	---	70
Bulgaria Feb 1972 (8)	Specialized	Medicine.	Peking	---	---	---
Canada Aug-Sep 1972 (14)	National	Farm machinery, aircraft, electrical equipment, heavy transport (Caterpillar-Gracil truck for work on rough terrain), model of Canadair CL-215 (fire-fighting aircraft), chemicals, forestry products, pharmaceuticals, mining equipment, logging machinery. 300 technical presentations given. Estimated cost: $2.0 million.	Peking	---	250,000	206

Appendix A (continued)

Country, Date, (No. of Days)	National or Specialized	Products and Equipment Exhibited	Location	% of Display Sold	Attendance	No. of Firms
Apr 1974 (11)	Specialized	Electronic systems, components, & special devices, geophysical instruments, medical equipment, communications, laboratory & scientific instruments. All equipment highly sophisticated. (Sophistication of products allegedly eliminated danger of patent infringement, making copying extremely time-consuming--by time equipment could be copied newer models would be developed.) 93 seminars held on geophysics, medical & electronic instruments, industrial communications & aircraft electronics. Qualified end-users from all over China are believed to have attended seminars.	Shanghai (First major trade fair held by West nation outside Peking)	30-60	40,000 Invitation only	36
Denmark[a]						
Mar 1972 (17)	National	Electronic instruments, food-processing equipment, machine tools, marine equipment (vessels & diesel engines), textile machinery, chemicals (insecticide & fertilizers), foundry equipment, cement-making machinery.	Peking	75-80	100,000	50
Aug 1974 (10)	Specialized	Electronics. High-ranking CCPIT & Chinese electronic industry officials attended.	Shanghai	100 (est.)	Invitation only	10
Sep 1974 (10)	Specialized	Medical instruments.	Peking	---	---	---
East Germany						
Jun 1973 (10)	Specialized	Machine tools.	Shanghai	---	30,000	---
1974	Specialized	Agricultural machinery.	Shenyang	---	---	---
1975 (Planned)	Specialized	---	---	---	---	---
France						
Nov-Dec 1972(15)	National	Scientific & technical: aeronautics, electronics, metallurgy, & medical science.	Peking	---	50,000	---
Jan 1973 (16)			Shanghai	---	---	---
Oct 1973 (11)	Specialized	Scientific instruments (nuclear, radio-controlled measuring equipment, analytical instrumentation).	Peking	---	20,000	29
May-Jun 1974(16)	National	Industrial: equipment for mining, aerospatial, & medical research, chemical & petrochemical industries, road transport, electronic data-processing equipment, chemicals, engineering & electrical equipment, transportation, public works & medical systems. Discussions held between Chinese & French technicians on 148 technical subjects.	Peking	50-60 Includes IRIS-60 computer & all data processing equipment	200,000	270

<u>Hungary</u>						
Aug 1971 (7)	Specialized	Medical instruments & medicine.	Peking	---	---	---
Aug 1972 (11)	Specialized	Machinery & motor vehicles.	Tientsin	---	---	---
Apr 1974 (9)	Specialized	Electrical lamps & instruments, thermal containers, enameling equipment.	Peking	---	---	---
1975 (Planned)	Specialized	Machinery.	Peking	---	---	---
<u>Italy</u>						
Oct 1972 (13)	National	Industrial: machine tools for woodwork, metalwork; plastic products; electro-medical, scientific, & precision instruments; public & industrial transport. 60 technical conferences held, 40 scientific & technical films shown.	Peking	---	200,000	290
<u>Japan</u>						
Jan 1972 (16)	Specialized	Precision electronic measuring instruments.	Tientsin	---	---	13
Mar 1972 (13)	Specialized	Machine tools.	Shanghai	---	---	13
Apr 1972 (14)	Specialized	Construction machinery. 130 technical seminars held.	Tientsin	---	35,000	8
Jun-Jul 1973(15)	Specialized	Automatic, electronic, & medical equipment, computers, industrial robots, color television broadcasting systems. (28 items on display were on COCOM embargo list but were displayed with COCOM approval: Japan sought COCOM approval for planned sale of these.)	Peking	---	100,000	---
Nov 1974	Specialized	Agricultural machinery & fertilizer. Forestry products, livestock, fisheries, food processing, scientific research & engineering equipment. Sponsored by Japan Assn for Promotion of International Trade.	Peking	---	---	200
Nov 1974	National	Printing & packaging. Demonstration of latest Japanese processes.	Tientsin	---	---	100
Nov 1975 (Planned)	National Specialized	Industrial technology: this exhibition intended as showcase for most advanced Japanese technology; laser systems, electronic medical equipment, & advanced electronic computers. Teams of engineers & technicians to discuss technical subjects with Chinese experts from all over China. Over 600 exhibits (100 government, 500 commercial). Exhibition to include history of cultural exchanges between China & Japan during last 2000 years. Sponsored jointly by Jetro & Japanese Government.	Peking	---	---	400-500

Appendix A (continued)

Country, Date, (No. of Days)	National or Specialized	Products and Equipment Exhibited	Location	% of Display Sold	Attendance	No. of Firms
Mexico Sep 1974 (17)	National	General economic & trade exhibition. Display of minerals, textiles, foodstuffs, cotton, grain, iron & steel ingots, petrochemical products, plastics, transport machinery, optical instruments.	Peking	---	---	75
Netherlands Nov-Dec 1973(13)	National	Industrial technology: models of water conservation projects, port construction, shipbuilding & repair, electronic instruments, medical apparatus, products of chemical, machinebuilding, food-packing industries. Chinese & Dutch discussed 50 technical topics.	Peking	---	60,000	---
Norway Mar 1973 (5)	Specialized (single firm)	Exhibition-seminar by state-owned Kongsberg Vapenfabrikk (gas-turbine and industrial electronics manufacturer). Anticipated that PRC will manufacture firm's gas turbines & electronic equipment under license. Extensive discussions on technical problems between Chinese & Norwegian engineers.	Peking	100	500 (seminars) 2300 (displays)	---
Poland Dec 1972 (14)	Specialized	Building & mining machinery, engines (compression-ignition), heavy duty excavators, 35-ton crane, tractors, aircraft models, aircraft & automobile engines, models of complete plants.	Peking	---	50,000	---
Sep 1974 (16)	Specialized	Mining machinery & electrical equipment, motor vehicles & electronically controlled machines. Specialists gave lectures.	Tientsin	---	30,000	---
Romania Oct 1971 (14)	National	Industrial: artisan products, machine tools, precision instruments, vehicles, agricultural equipment, & petrochemical industry plant.	Peking	---	400,000	---
Aug 1974	National	Electronic computers, telecommunications equipment.	---	---	---	---
Sweden Apr 1972 (11)	National	Industrial: motor vehicles, mining equipment, optical instruments, medical apparatus.	Peking	---	200,000	147

Switzerland Aug 1974 (12)	Specialized	Machine tools, watches, precision equipment, textile & printing machinery, chemicals, electrical & heavy machinery. Extensive meetings with Swiss government & commercial representatives on finance, oil exploration, shipbuilding, steel mills. Chinese requested detailed blueprints of machinery on display.	Peking	---	---	200
United Kingdom[b] Mar-Apr 1973(13)	National	Industrial machinery & technology; avionics; instrumentation (flow & level measurement, metering & analytical instrumentation for lab & industrial uses, flight deck instruments, etc.); machine tools; semiconductors; computers (for use in Concorde project & Trident aircraft, civil engineering problems, planning & scheduling large projects with controlled systems, electronic components for control systems); telecommunications (television equipment & systems); petrochemical & agricultural chemical production; model of integrated rolling mill; plant for steel, nonferrous industries; petroleum refineries, power generation; advanced electronics & airport electrification; diesel engines; nuclear components to radar systems; mining equipment; equipment for underground civil engineering construction (e.g., tunnel boring). Focus of the Exhibition was on new British industrial production & technology (many of the products/systems had never been displayed before). British conducted a program of 227 lectures & 63 industrial films (backed up by demonstrations & technical displays). Estimated cost: $2.5 million. This Exhibition had been preceded in December 1972 by a 24-member trade mission to Peking which delivered 35 technical lectures of 3 hours each to several hundred technicians & engineers from all over China in the fields of aerospace, color television, xerography, chemicals, machine tools, pharmaceuticals, etc. Chinese advised British what they wished to see at the 1973 Exhibit.	Peking	60-70	200,000	346
Mar 1975 (10)	Specialized	Follow-up to 1973 Exhibition with amplification of sectors which had aroused particular interest. Exhibition replete with range of sophisticated machine tools, numerical control systems used in milling, drilling, and cutting of metals, tube-sealing instruments which enable remote-control welding repairs to be made in thermal & nuclear boilers	Shanghai	---	---	60

Appendix A (continued)

Country, Date, (No. of Days)	National or Specialized	Products and Equipment Exhibited	Location	% of Display Sold	Attendance	No. of Firms
		(this equipment also has uses in offshore oil drilling), marine survey equipment, medical & clinical instruments, electronic testing equipment. 300 company representatives took part in discussions, seminars, lectures & technical film presentations of their products.				
West Germany Sep 1975 (14)	National	Industrial.	Peking	---	---	---
Yugoslavia Dec 1971 (15)	National	Industrial. Yugoslavs were able to meet 1000 Chinese experts from various ministries & industries.	Peking	---	200,000	200

SOURCES: *China Trade Report*, 1971-1975; *Business Asia*, 1973-1975; *Asia Research Bulletin*, 1971-1975; *China Trade & Economic Newsletter*, 1973-1975; *U.S.-China Business Review*, 1974-1975.

NOTE: On Chinese side, exhibitions are handled by the Department of Foreign Exhibitions of the China Council for Promotion of International Trade (CCPIT). Foreign sponsorship may involve trading companies, industry associations, government agencies, e.g., Japan External Trade Organization (JETRO), Association for Promotion of International Trade-Japan (JITPA), Danish Department of Trade and Industry, Swedish Export Association, Canadian Department of Trade, Industry and Commerce, Italian Ministry of Foreign Trade, Sino-British Trade Council, British Department of Trade and Industry, Austrian Federal Chamber of Commerce, Australian Department of Overseas Trade, National Federation of Electronic Industry (France), etc.

[a]First Danish exhibition in PRC was organized by a group of private electronic companies in 1965, followed by a government-sponsored industrial display in 1967. Denmark was last foreign country to stage an exhibition before Cultural Revolution and first one to do so after it.

[b]For a more detailed listing of firms and technological equipment displayed at 1974 exhibition, see *China Trade and Economic Newsletter*, March 1973.

Appendix B

INDUSTRIAL PLANTS AND MAJOR COMPONENTS PURCHASED BY THE PRC 1963-FEBRUARY 1975*

The table that follows attempts to provide as complete and accurate a compilation of industrial plant purchases by the PRC over the past dozen years as the available data permit. The compilation is arrayed by principal industry-group (iron and steel; power generating; petroleum exploration and extraction; petroleum refining, petrochemical, and synthetic fiber; chemical fertilizer; and other). Within each industry group, plant purchases are listed in chronological order by date of contract. Plants still under negotiation by September 1974 are listed in order of reported date of opening of negotiation.

Deciding which major purchases the category of "complete plants" should include or exclude was not easy. Basically, a restrictive definition was adopted: only purchases that covered an entire, integral manufacturing or production process or a complex of such processes were included. That meant excluding some quite large purchases of sets of equipment -- in particular, $132 million worth of coal and ore mining equipment and $100 million worth of dredgers purchased by the Chinese during 1972 and 1973. While these must certainly be considered "productive plant," they seem to fall far short of being "complete plants." Two exceptions, however, were made: (1) sets of turbo-generators were included, even though they were not complete power generating plants, on the grounds that the turbo-generator represents quite obviously the technological heart of the power station; and (2) petroleum exploration and extraction equipment (offshore drilling platforms, oil rig supply vessels, survey craft, etc.), on the grounds that

---

*The author is indebted to Jeanette Koch of The Rand Corporation for her painstaking compilation of the data and development of the format for this table. Valuable contributions to this effort were provided by Kim Morrissey of Rand. The author is grateful also to William Clark of the Bureau of East-West Trade, U.S. Department of Commerce, for advice on technical interpretation of the plant data, particularly in the petrochemical industry group.

they constitute large and highly significant capital acquisitions in an industry that is currently of exceptional interest.

It should be noted that the data for the table were culled from a great variety of sources (see listing below); not all have a good track record of reliability, and they often feed on one another. Since the ultimate source of most of the information on these plant sales is the selling enterprise, and since these enterprises have understandable proprietary interests in protecting this information, or even in dissembling, independent verification is most difficult. In spite of considerable effort to reconcile discrepancies, eliminate duplication, and confirm claims, some questions of fact and interpretation remain unresolved.

An attempt was made to obtain consistent plant capacity figures. In the chemical fertilizer grouping, the capacity ratings are stated in metric tons per year (MT/yr). For the large plants purchased in the 1970s, these annual capacities are derived from an average *daily* output for (1) ammonia plants, of 1000 MT, and (2) urea plants, of 1600 MT, multiplied by 330 operating days per year. This is based on U.S. experience. If, under Chinese conditions, the plants should experience more days of down-time, the *annual* capacity would be correspondingly reduced. For the three urea plants in the 1974 Heurtey complex, the daily output rating is 1740 MT, rather than the 1600 MT for the other urea plants. The chemical fertilizer plants purchased in the 1960s, of course, have lower capacity ratings, since the technology of that period was less advanced.

The cost figures are probably subject to the largest margin of error, since it is not always clear to what extent royalty payments and license fees for technology are included, whether interest charges are fully reflected, what foreign exchange conversion rates should apply, and so forth. The conversion rates used were taken from the *FAO Trade Yearbook* volumes for the years through 1972, and reflect average rates of exchange for the floating exchange rate period of 1973-1974.

Following is a list of the principal sources used:

1. *Asia Research Bulletin*
2. *Aviation Week & Space Technology*
3. *Business Asia*
4. *Business International*
5. *Business Week*
6. *China News Analysis*
7. *China Trade Report*
8. *China Trade and Economic Newsletter*
9. *Christian Science Monitor*
10. *Current Background*, American Consulate General, Hong Kong
11. *Current Scene*, The Green Pagoda Press, Ltd. (for United States Information Service, Hong Kong)
12. *Economic Profile of Mainland China*, Vols. 1 and 2, February 1967. Study prepared for Joint Economic Committee, U.S. Congress.
13. *Electronic News*
14. *Far Eastern Economic Review*
15. *Far East Trade & Development*
16. *Japan Economic Journal*
17. *JETRO China Newsletter*
18. *PRC Daily Report*, Foreign Broadcast Information Service (FBIS)
19. *PRC: International Trade Handbook*, Research Aid A-73-29, Central Intelligence Agency, October 1973
20. *Ta Kung Pao*
21. *The New York Times*
22. *The Washington Post*
23. *Trade Yearbook*, Vols. 19 (1965) and 25 (1971), Food and Agricultural Organization of the United Nations (FAO), Rome
24. *Translations on People's Republic of China*, U.S. Joint Publication Research Service (JPRS), Washington, D.C.
25. *U.S.-China Business Review*, National Council for U.S.-China Trade, Washington, D.C.
26. *Vneshniaia torgovlia SSSR, Statisticheskii obzor* (Foreign Trade of the USSR, Statistical Survey) for 1972 and 1973, Moscow, 1973 and 1974.

Table B-1

IRON AND STEEL PLANTS

Plant Profile	Country and Firm	Contract Signed	Delivery Period	Value (million $US)	Remarks
Cold-rolling mill (special steel) Capacity: ---	West Germany Schloemann AG (subsidiary of Gutehoffnungshütte AV) France Sino-France	1965-Early 1966	---	17.0 (of which: 10.0 7.0)	---
Steel mill (Linz-Donau) Capacity: 650,000 MT/yr raw steel Location: Taiyuan (Shansi) iron & steel industrial park.	Austria VOEST	1965	1966-1968	12.0	Negotiations began in 1963. VOEST is originator of basic oxygen furnace (BOF). Plant was assembled by Chinese; West German engineers & Austrian technicians participated in supervising assembly. Two 55-ton oxygen furnaces reported put into operation in 1969.
Pipe & tube-drawing plant Capacity: ---	Italy	1965	---	3.0	
Seamless steel tube plant Capacity: ---	Italy Innocenti	Sep 1965	---	3.2	Payment: 10% down; balance on completion.
Wire-drawing plant Capacity: ---	Japan	1965	---	5.0	
Steel tube plant Capacity: 40,000 MT/yr	United Kingdom Lowey Engineering, Ltd (in cooperation with Mannesman of West Germany)	1967	1968	11.0 (of which: 6.0 for Lowey)	Lowey cancelled contract reportedly under pressure from U.S., but Mannesman shipped plant & equipment in 1968.
Iron works Capacity: ---	Japan Hitachi Engineering	1972	---	---	It is not clear whether this is an iron foundry or blast furnaces for making pig iron.
Small steel mill Capacity: ---	Japan Sumitomo Metal	1972	---	5.24	This may be a continuous-casting plant.
Steel-rolling mill Capacity: ---	West Germany Demag AG	1972	---	80.0	

Steel complex Capacity: 4 million MT/yr	West Germany Mannesman AG Thyssen	---	---	408.0	Under negotiation as of January 1974.
Iron & steel complex Location: Wuhan Cold-rolled steel sheet, strip & finishing department. Cold strip mill with facilities for tinning, silicon steel & possibly galvanized sheet. Tinning plant probably supplied under Nippon contract (see next item).	West Germany Demag AG Schloemann AG Siemag Siegener Maschinenbau GMBH ACEC (Belgian sub of Westinghouse Electric) Allgemeine Elektrizitäts-Gesel-schaften AEG-Telefunken August Thyssen-Hütte AG-Rasselstein AG Brown, Boverie & Cie AG (sub of Brown, Boverie & Cie (Switz.) DSD Dillinger Stahlbau GMBH Gewerkschaft Kerma-chemie Hochtief AG für Hoch- und Tief-bauten, Vorm. Gebr. Helfmann Otto Wolff AG Maschinenfabrik Sack GMBH Siemens AG Waagner-Biro AG (Austrian sub of Osterreichische Länderbank AG) Ed. Zublin AG Bauunternehmung	Mar 1974	1976-1977	198.0	Terms: All cash. PRC to transfer 90% of purchase price in DM to Deutsche Bank/ Duisburg. From this, 10% down payment to be released initially; another 10% instalment after 9-10 months; remaining 70% staggered over 13th through 33rd month. Final 10% to be released in two 5% instalments. First instalment after performance tests concluded and material guarantees verified in 1977. Final instalment no later than March 1979. Training: Germans to train 170 technicians in West Germany & other European steel plants. 230 German specialists to be sent to Wuhan. Total steel complex (including Nippon contract below) will reportedly add 25% to Chinese rolled steel capacity. Negotiations between Chinese & Demag, Siemag, & Schloemann for large-scale steel-rolling mill date to 1966, but were broken off in 1968 reportedly under U.S. pressure.

Table B-1 (continued)

Plant Profile	Country and Firm	Contract Signed	Delivery Period	Value (million $US)	Remarks
Hot-rolled steel-sheet & strip mill department 1 hot strip mill Capacity: 3 million MT/yr Contract includes silicon steel-sheet mill (capacity: 70,000 MT/yr) and tinning plant (capacity: 100,000 MT/yr) probably for cold strip mill department.	Japan Nippon Steel Mitsubishi Heavy Ind. Ishikawajima-Harima Heavy Ind. (IHI) Toshiba Hitachi Mitsubishi Electric (plus 10 other Japanese firms)	May-Jun 1974	1975-1977	228.5	Contract denominated & payable in yen (previous contracts have been denominated & payable in yuan), & includes $15.6 million worth of technology. Terms: 10% deposit; 20% to be paid on shipment & 10% when trial operations commence; remaining 60% reportedly to be paid under a deferred-payments arrangement. Training: About 350 Japanese experts will live near site during construction & start-up period, over 200 Chinese technicians will be trained at 3 major Nippon Steel plants at Oita, Kimitsu, and Hirohata.
Surface water recirculation & disposal plant Transformers Desulfurization plant for coke oven gas Related steel construction materials & pipe	Japan Kurita Water Industries Chiyoda Chemical Engineering & Construction	Oct 1974	---	65.0	This plant & equipment is for above Nippon Steel mill; total value of contract is reported to be $100.0 million (of which $65.0 million has been obligated). Drainage disposal system is estimated at $32.5 million. Terms: Assumed to be the same as for the Nippon Steel mill.
Continuous casting mill Capacity: 1.5 million MT/yr alloyed & unalloyed steel (includes 3 ingot slab casting machines of circular arch construction type)	West Germany Demag AG Mannesman (Düsseldorf) Switzerland ConCast (Zurich)	Oct 1974	1977	58.0	Part of the major integrated steel complex being built at Wuhan. Terms: Progress payments.
Thermal electric power plant 1 steam turbine 1 thermal generator 1 oxygen generator	Japan Mitsubishi Electric Hitachi Engineering Toshiba	Early 1972	---	13.0	

Table B-2

POWER PLANTS

Plant Profile	Country and Firm	Contract Signed	Delivery Period	Value (million $US)	Remarks
Thermal electric power plant(s) Total capacity: 300 MW 4 steam turbo-generators	USSR	1972	1972	8.2	
Thermal generator (1) Capacity: ---	Italy Gruppo Industrie Electromechnichi per Impianti all' Estero (GIE)	1972	---	1.7	It is not clear what equipment was involved in contract.
Gas turbine generators (5) Capacity (each): 25 MW (Model PG 5331) Ancillary equipment	United Kingdom John Brown Engineering, Ltd	Jun 1972	1972 (2d half)	8.4	Cash payment. Sets to be modified for use in China; river water to be used for lube oil cooling.
Hydroelectric power plant Capacity: --- 3 complete generating sets	Sweden Karlstade Mekaniska (Verkstaeder & ASEA)	Jul 1972	Jun 1973 (in operation 1st half 1974)	4.0	
Thermal electric power plant Total capacity: 250 MW 2 steam turbines (125 MW each) 2 generators electrical control gear high pressure water supply pump, valves & other auxiliary equipment (except boilers)	Japan Hitachi Engineering	Aug 1972	Apr 1974 for equipment	30.0	Quoted in yuan; cash payment in sterling. This is first plant of its kind Japan has exported to PRC, also biggest industrial plant exported under Japanese/Chinese Memorandum Trade Program. In 1972 it was reported that plant would be largest of its type in China; it will go into operation spring 1975.
Hydroelectric power plants (2) Capacity (each): 75 MW 2 turbines	France Alsthom Compagnie (Français-Thomson-Houston-Hotchkiss-Brandt SA); & Ste Creusot-Loire (Schneider SA)	Dec 1972	1974-1975	10.0	
Thermal electric power plant(s) Capacity (each): 700 MW 7 steam turbo-generators	USSR	1972	1973	16.38	

Table B-2 (continued)

Plant Profile	Country and Firm	Contract Signed	Delivery Period	Value (million $US)	Remarks
Power-generating plant Capacity: ---	Switzerland	1972-1973	---	---	
Thermal electric power plant (Coal-burning) Total capacity: 500 MW 2 steam turbines (250 MW each) 2 generators electrical control gear high pressure water supply pumps, valves, piping & other equipment (except boilers)	Japan Hitachi Engineering	Sep 1973	1974-1975	72.0	Financing: Japanese Ex-Im Bank. 10% down payment (on signing of contract); 15% at time of shipment; 5% on completion of guarantee period (or 28 months after shipment); balance (70%) in 10 instalments at 6% over 5.5-year period.
Gas turbine generators (5) Capacity (each): 25 MW Modifications include river water for lube oil cooling & a rearrangement of exhaust system.	United Kingdom John Brown Engineering, Ltd	1973 (fall)	---	8.2	
Thermal electric power plant Capacity: --- 3 gas turbines 3 electric generators	Belgium Ateliers de Construction Electrique de Charleroi (ACEC) (generators) Canada Westinghouse (turbines)	1973	1975	5.0	
Thermal electric power plant (Oil-fired) Total capacity: 650 MW 2 turbo-generators (325 MW each)	Italy Gruppo Industrie Electromechnichi per Impianti all' Estero (GIE)	Mar 1973	---	86.2	Terms: Five years at 6%.
Thermal electric power plant (Coal-fired) Total capacity: 300 MW Includes single valve steam generator, heated with soft coal and auxiliary machinery	France Compagnie Electro-mechanique Switzerland Brown Boverie Group Gebrueder/Sulzer Aktiengesellschaft (Winterthur)	May 1974	1976 (Operational)	40.0	Includes equipment, technology & advisory personnel for instaling & setting plant in operation. CEM is responsible for technical and commercial side of power station, Sulzer for boiler supplies and engineering.
Turbo-alternators (3) Capacity (each): 100 MW	Czechoslovakia Skoda export	1972-1973	Apr 1974	---	Machine tested in presence Chinese engineers before shipment (to

Table B-3

PETROLEUM EXPLORATION AND EXTRACTION PLANTS

Plant Profile	Country and Firm	Contract Signed	Delivery Period	Value (million $US)	Remarks
Oil-drilling equipment Capacity: ---	France	1965	---	4.86	
Offshore drilling platforms Capacity: 400 tons Second-hand barge *Fuji*, tenders & parts Work ship *Kuroshio*	Japan Nippon Kaiyo Kussaku Japan Offshore Drilling Co. (Mitsubishi)	Sep 1972	Mar 1973	9.8	
Offshore drilling platform No. 2 Hakuryu (heavy duty)	Japan Mitsubishi Heavy Industries	Dec 1973	1975	22.6	Operable up to 20 meters deep. For development of oilfield on continental shelf, Yellow Sea to South China Sea.
Offshore drilling platforms (2)	Japan Japan Oil Development Corp. (Mitsubishi)	1973(?)	1973	41.0	Reported as oil drilling & exploration ships.
Oil rig/supply & towing vessels (8) (160' long)	Denmark Weco Shipping Aarhus Flydedok A/S	Late 1973	1974-1975	20.0	Vessel can service up to 10 rigs. Reportedly for use in Pohai Gulf.
Oil rig supply vessels (5)	Japan Mitsui Shipbuilding & Engineering	---	---	---	Under negotiation.
Supply boats (Diesel) (5) Capacity (each): 660 tons	Japan Hitachi Shipbuilding & Engineering	Sep 1973	---	10.0	For maintenance & repair of port facilities & for developing offshore oil; will be fitted with rescue & firefighting equipment.
Tugboats (2) Capacity (each): 9,000 hp Capacity (pulling): 82 tons		Dec 1973	1975	16.7	
Undersea survey craft (2) & 500-ton survey ship	Japan Sumitomo Shoji Ocean Systems (Japan) Niigata Engineering	---	---	---	Under negotiation.

Table B-3 (continued)

Plant Profile	Country and Firm	Contract Signed	Delivery Period	Value (million $US)	Remarks
Supply boats (8) for offshore drilling	Denmark Weco Shipping	1974	---	---	
Data processing center 2 Control Data Cyber 172 computer systems (medium scale) & all equipment necessary for seismic data collecting & processing	France Compagnie Générale de Géophysique (CGG) Control Data/ France	Sep 1974	---	7.0	For coordination of development of China's oilfields. Application of software, system integration, training of Chinese technicians, & other support services to be completed in France. These are largest computers yet sought by PRC. Sale is under review by U.S. Office of Export Administration.
Ship completely equipped for marine seismic surveys	France Compagnie Générale de Géophysique (CGG)	Prior to Sep 1974	---	---	

Table B-4

PETROLEUM REFINING, PETROCHEMICAL, AND SYNTHETIC FIBRE PLANTS

Plant Profile	Country and Firm	Contract Signed	Delivery Period	Value (million $US)	Remarks
Ethylene, hexanol & butanol plants (2) Capacity: 300,000 MT/yr	France Melle & Speichem	1963	---	8.50	
Vinylon fibre plant Capacity: 11,000 MT/yr	Japan Kurashiki Rayon	Sep 1963	1964	20.0	
Vinylon plant Capacity: 18,000 MT/yr	Japan Dai Nippon	---	1963	30.0	
Oil refinery Capacity: 150,000-200,000 MT/yr	Italy ENI Group	Dec 1963	---	5.0	
Acetylene gas generating plant Capacity: 1,100 cu m/yr	Japan	May 1964	1967	3.0	Complements 1963 Kurashiki vinylon plant (see above).
Perlon (synthetic fibre) plant Capacity: --- Location: Shanghai (suburbs)	West Germany Friedrich Uhde, GMBH	Jul 1964	---	1.75	Terms: Cash on delivery.
Heavy crude-oil-cracking & olefins-separation plant Capacity: 50,000 MT/yr Location: Lanchow	West Germany Lurgi-Gesellschaft	Jul 1964	1968	12.5	Terms: Cash.
High-pressure polyethylene plant Capacity: 24,000 MT/yr	United Kingdom Simon Carves, Ltd	Sep 1964	---	12.6	Plant uses ethylene produced by olefins-separation plant purchased from Lurgi-Gesellschaft (see above).
Polypropylene plant Capacity: ---	United Kingdom	Nov 1964	---	7.3	Both resin & fibre products to be made from propylene produced by Lurgi-Gesellschaft olefins-separation plant.
Acrylonitrile plant Capacity: 10,000 MT/yr	West Germany Lurgi-Gesellschaft	May 1965	1967	11.0	
Naphtha-cracking plant Capacity: ---	Norway	Jul 1965	---	14.0	
Polyester resin plant Capacity: ---	United Kingdom Scott Bader	1963-1965	---	---	

Table B-4 (continued)

Plant Profile	Country and Firm	Contract Signed	Delivery Period	Value (million $US)	Remarks
Acrylic resin plant Capacity: --- Location: Lanchow	United Kingdom Prinex, Ltd (affiliate of Courtaulds, Ltd)	Sep 1965	1968	8.4	Terms: 10% down. Majority of outstanding balance to be paid by promissory notes with 5-year usance, except for a small part to be paid on completion of project; 2-year credit also extended. Service and parts replacement agreement included in contract.
Oil refinery Capacity: ---	Italy Snam Projetti (ENI Group)	Sep 1965	---	9.0	
Aromatic chemicals plant Capacity: 70,000 MT/yr	Italy Snam Projetti (ENI Group)	1966	---	5.5	
Vinylon plant Capacity: ---	Japan Kuraray	Jun 1972	---	---	Financing: Japanese Ex-Im Bank (1st instance of financing of China trade by Japanese Ex-Im Bank). Authorized by decree of July 26, 1972, which nullified "Yoshida Letter" banning use of Bank funds in China trade because of Taiwan.
Chemical fibre plant Capacity: ---	Japan Kurashiki Rayon Co.	Jul 1972	---	18.9	
Ethylene plant (1) Capacity: 300,000 MT/yr Technology: Lummus	Japan Toyo Engineering Co. (TEC) Mitsui Toatsu Chemical C. Itoh Toko Bussan	Dec 1972	1973-late 1975	46.0	Financing: Japanese Ex-Im/Commercial Bank. FOB 20% down; 80% deferred payment over 5 years at 6% per year on completion of plant. Contract calls for package of yuan & yen, TEC receiving yen & Lummus receiving payment through Japanese licensee. Contracted for & payable in yuan. Technical assistance fee 10%. (Lummus is subsidiary of U.S.-based Combustion Engineering Co.; TEC-Lummus arrangement dates back 10 years, calls for basic engineering & technical assistance.) Lummus received U.S. Dept. of Commerce license & clearance.
Butadiene plant (1) Capacity: 45,000 MT/yr Technology: Nippon-Zeon	United States Lummus Co.				

Synthetic fibre plant Capacity: ---	Japan Toray Industries	1972	---	90.0	
Acetic acid plant Capacity: ---	Japan Kaisha	1972	---	---	
Ethylene & polyvinyl alcohol (poval) plant Capacity: 120,000 MT/yr Technology: Lummus/Nippon-Zeon Ethylene plant has hydrogenation unit for oil cracking; plant uses kerosene, diesel, other type oils instead of naphtha.	Japan Mitsubishi Petrochem. Mitsubishi Heavy Ind. Mitsubishi Corp. Western Japan Trading United States Lummus	Feb 1973	End 1973-1975	34.0	Financing: Japanese Ex-Im/Commercial Bank. 20% down, 80% over 5 years at 6% p.a.
Ethylene vinyl acetate plant(1) Capacity: 66,000 MT/yr Polyvinylalcohol (poval) plant (1) Capacity: 33,000 MT/yr Technology: Bayer & Kuraray	Japan Kuraray Industries West Germany Bayer	Mar 1973	1974-1976	26.0	Financing: Japanese Ex-Im/Commercial Bank. 30% down payment; 70% in 10 semiannual instalments (in yuan) over 5 years at 6% per year beginning after final shipment. Bayer receiving lump sum payment directly from PRC. (In 1963 Kuraray sold PRC a vinylon plant with capacity of 11,000 MT/yr. Terms were 25% down, 6% per year for 5 years with export restriction imposed on PRC for 10 years after start-up.)
Synthetic fibre plant complex Acrylonitrile plant Capacity: 50,000 MT/yr Acetonitrile plant Capacity: 1,000 MT/yr Cyanic acid plant Capacity: 5,000 MT/yr Waste-water treatment plant Technology: Asahi/Sohio Contract provides for supply of Sohio Catalyst 41 for new plants. Will give PRC one of world's most modern waste-reducing techniques, increasing production 40-50% over earlier generation catalysts.	Japan Asahi Chemical Co. Niigata Engineering Asaki Chemical Ind. Chori Trading Co. United States Sohio	Mar 1973	1974-1976	29.0 (not including license fee)	Financing: Japanese Ex-Im Bank. Semiannual instalments over 5 years at 6% per year in yuan. Extra payment by PRC of $US 8 million direct to Sohio, channeled through Japanese Bank; 7 instalments over 5 years; first payment due 60 days after contract is approved by Japanese Govt, followed by payments in Aug-Sep 1973 & 4 annual payments 1974-1977, adjusted to inflation. PRC bought process, license, & plant as single unit; license does not call for free exchange of future improvements in Sohio technology. PRC may export plant's output.

Table B-4 (continued)

Plant Profile	Country and Firm	Contract Signed	Delivery Period	Value (million $US)	Remarks
					Training: Asahi responsible for training Chinese engineers in Japan. No Sohio engineers involved in setting up plant or its operation.
Polyester polymerization plant (1) Capacity: 25,000 MT/yr Technology: Toray-based on improved Imperial Chemical Industries (ICI) process	Japan Toray Industries Mitsui Shipbuilding	May 1973	1974-1976	49.0	Financing: Japanese Ex-Im/Commercial Bank.
Aromatic extraction plant (1) (Benzol-toluol-xylol) (BTX) Capacity: 50,000-60,000 MT/yr Technology: Universal Oil Products	Japan Sumitomo Chemical	May 1973	1974-1976	6.0	Financing: Japanese Ex-Im/Commercial Bank.
Vinyl acetate plant (1) Capacity: 90,000 MT/yr (Derived from natural gas) Methanol plant (1) Capacity: 300 MT/day Technology: Plant uses residual gas from acetylene production; will employ ICI low pressure synthesis method & an Onia catalytic particle oxidation process licensed by P.E.C. Engineering of Paris.	France Speichem, Lurgi Virg. L'Aire Liquide Rhône-Poulenc United Kingdom Humphrey & Glasgow West Germany Badische Anilin und Soda Fabrik (BASF)	May 1973	1974-1976	90.0 (including technology)	Probably deferred payments over 5 years. Synthetic fibres indicated as end-use.
Polyethylene plant (1) Capacity: 60,000 MT/yr Technology: Based on improved version of high pressure process (BASF) imported from West Germany	Japan Mitsubishi Petrochem. Hitachi, Ltd Chori Trading Co. Western Japan Trading	July 1973	1974-1975	22.0	Financing: Japanese Ex-Im/Commercial Bank. Deferred payment over 5 years at 6% per yr.

Acetaldehyde plant (1) Capacity: 30,000 MT/yr Technology: Uhde & Hoechst Location: Near Shanghai	West Germany Friedrich Uhde & Farbwerke Hoechst	July 1973	1974-1975	4.0	Terms: Cash. 50% down, 40% on delivery, 10% on acceptance.
Polyethylene plant (1) (High pressure, low density) Capacity: 180,000 MT/yr Technology: Based on improved version of ICI process	Japan Sumitomo Chemical Ishikawajima-Harima Heavy Industries	Aug 1973	1974-1976	41.0	Financing: Japanese Ex-Im/Commercial Bank.
Petrochemical & synthetic-fiber complex (16 of 18 units) Capacity initial: 500,000 MT/yr full: 2 million MT/yr Location: 50 km south of Shenyang	France Technip-Speichem Consortium Some West German & U.S. technology	Sep 1973	1975-1978	282.0	Construction to begin in March 1975. Output for PRC consumption only. Financing: Crédit Lyonnais, Banque de L'Union Européenne, & Banque Française pour le Commerce Extérieur. Deferred payment over 5 years after delivery of plant.

ORGANIZATION OF THE PETROCHEMICAL AND SYNTHETIC-FIBER COMPLEX[a]

Production	Capacity	Technology
Catalytic Reforming	155,000 MT/yr	---
Hydrogen	5,000 cu m/hr	Technip
Ethylene	73,000 MT/yr	Institut Français de Pétrol (IFP) & Speichem
Ethylene Oxidation Process	35,000 MT/yr	Chemische Werke Huls (CWH)
Ethylene Glycol	35,000 MT/yr	Chemische Werke Huls (CWH)
Gasoline Hydrogenation	65,000 MT/yr	IFP & Speichem
Aromatics Extraction	163,000 MT/yr	IPP
Paraxylene	123,000 MT/yr	Atlantic Richfield Engelhard
Dimethylterephtalate	88,000 MT/yr	Dynamit Nobel
Polyester	87,000 MT/yr	Rhône Poulenc
Nitric Acid	54,000 MT/yr	Rhòne Progel
Cyclohexane	45,000 MT/yr	IFP
Cyclohexanol-Cyclohexanone	45,000 MT/yr	Sociéte des Usines chimique Rhône Poulenc (SUCRP)
Adipic Acid	55,000 MT/yr	SUCRP
Hexamethalyne-diamine	22,000 MT/yr	SUCRP
Salification	---	SUCRP
Nylon Crystallization	46,000 MT/yr	SUCRP

[a]Figure below is a flow chart of the petrochemical and synthetic-fiber complex.

Table B-4 (continued)

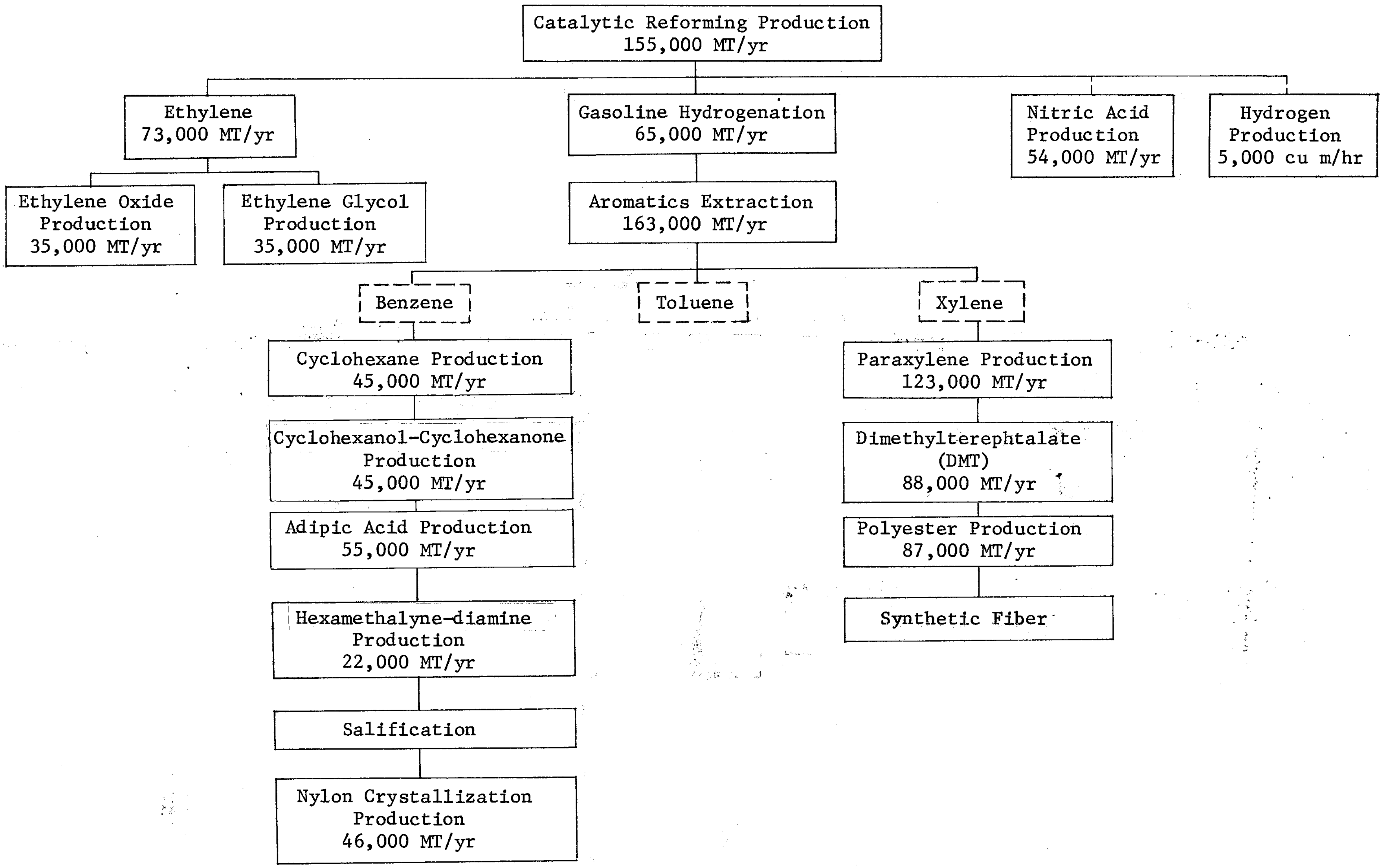

Fig. -- Flow chart for the petrochemical and synthetic-fiber complex

Table B-4 (continued)

Plant Profile	Country and Firm	Contract Signed	Delivery Period	Value (million $US)	Remarks
Petrochemical plant (1) (for production of polypropylene) Capacity: 35,000 MT/yr Technology: Standard Oil of Indiana	Italy Snam Projetti (ENI Group) United States Standard Oil of Indiana	1973	1975-1977	15.0	Financing: Cash. Normal terms. Snam Projetti is responsible for entire project. Standard Oil will train technicians.
Polypropylene plant Capacity: 80,000 MT/yr Technology: Mitsui Petrochemical plant is part of chain of derivatives of TEC/Mitsui 300,000-ton ethylene plant (see above). Design, engineering, manufacturing, and procurement of equipment for plant by Mitsui Shipbuilding.	Japan Mitsui Petrochemical C. Itoh Mitsui Shipbuilding & Engineering Kosho Trading Corp.	Oct 1973	1974-1976	26.0	Contract suspended at request of Japanese consortium in early 1974. Explanation given: competing domestic demands in Japan. Would have enabled PRC to produce polypropylene for first time.
Catalyzer production plant for production of titanium trichloride (catalyst for polymerization of polypropylene). Capacity: 220 MT/yr	C. Itoh Toho Titanium Kosho Trading Corp.	Jan 1974	1974-End of 1976	4.6	First such plant sold to PRC.
Vinylchloride monomer plant Capacity: ---	West Germany Friedrich Uhde	Jan 1974	1976	19.0	
Ethylene-glycol plant Capacity: 16,000 MT/yr Ethylene-oxide plant Capacity: 20,000 MT/yr	Japan Hitachi Shipbuilding Japan Catalytic Chem. Nippon Shokubai Kagaku (engineering) Nisso Petrochemical	Dec 1973	1977	17.0	Financing: Japan Ex-Im/Commercial Bank. 25% down; 5-year deferred payment at 6% p.a.

Table B-4 (continued)

Plant Profile	Country and Firm	Contract Signed	Delivery Period	Value (million $US)	Remarks
Polyester spinning & stretching plant 2 polyester staple machines Capacity: 13,200 MT/yr long & short polyester fibers 1 8-ton filament machine & related facilities Capacity: 26,401 MT/yr filament	Japan Teijin Nissho-Iwai Co., Ltd	Feb 1974	1975-1976	17.0	Financing: Japanese Ex-Im. Contract denominated & payable in yuan. Cost includes know-how & engineering. 35% down payment with 65% balance to be paid in equal instalments over 5-year period. Complements raw material plant purchased May 1973 from Toray.
Acrylic fiber plant Capacity: ---	Japan Japan Exlan Ataka Trading Co.				Under negotiation in March 1974.
Synthetic rubber plant Capacity: ---	Canada Polysar			20.0	Under negotiation in March 1974.
Polyvinyl alcohol plant Capacity: 45,000 MT/yr	Japan Kuraray	Feb 1974	1976	19.0	Financing: Japanese Ex-Im Bank. 15% down, balance to be paid over 5 years at 6.5% annual interest. Chinese will use plant for production of vinyl using Chinese technology. Complex may include an acetic acid vinyl plant.
Polyethelene plant (high density (low pressure)	West Germany Friedrich Uhde	Mar 1974	1975-1976	15.7	Cost includes engineering, installation, & equipment.
Nylon spinning plant (design & equipment) Location: Manchuria Capacity: ---	France Rhone Poulenc Textile	Aug	1977-1978	10.0	Deferred payment terms.
Polyvinyl alcohol plant Capacity: 45,000 MT/yr Location: Chungking	Japan Kuraray	Oct 1974	1975-1976	18.0	Financing: Japanese Ex-Im Bank (partial) 15% down, remainder over 7-8 years at 6.5% annual interest.

Table B-5

CHEMICAL FERTILIZER PLANTS

Plant Profile	Country and Firm	Contract Signed	Delivery Period	Value (million $US)	Remarks
Synthetic ammonia plant Capacity: 105,000 MT/yr Location: Lu-chou	United Kingdom Humphrey & Glasgow, Ltd	Oct 1963	1966	8.4	Progress payments with final payment six months after test operation. No special agreement on technology although separate provision made for use of British engineers. This plant intended to complement Dutch Stork-Werkspoor plant (see immediately below)
Urea plant Capacity: 175,000 MT/yr	Netherlands Stork-Werkspoor	Sep 1963	1966	7.0	
Ammonium nitrate plant Capacity: 110,000 MT/yr	Italy Montecattini	Dec 1963	---	14.2	Plant purchased by PRC for Albania. Contract includes facilities for production of ammonia, nitric acid, & ammonium nitrate fertilizer.
Synthetic ammonia plant Capacity: ---	Italy	Dec 1963	---	3.6	Compression chamber only; remainder of plant built by Chinese.
Ammonia plants (4) Capacity: ~ 40,000 MT/yr (each)	United Kingdom Humphrey & Glasgow, Ltd	Aug 1965	---	23.52	
Fertilizer plant Capacity: 150,000 MT/yr	Italy Montecattini	---	1965	7.5	
Chemical fertilizer plants (2) Capacity: ---	Japan Kagaku Mitsui Toso Trading	Apr 1972	---	---	
Ammonia plants (2) Capacity: ---	Japan Hitachi Shipbuilding Nippon Shokubo Kagaku Haishu	1972	---	---	

Table B-5 (continued)

Plant Profile	Country and Firm	Contract Signed	Delivery Period	Value (million $US)	Remarks
Urea plant complex (3 plants) Capacity (each): 480,000 MT/yr Technology: Dutch State Mines (DSM) Stamicarbon process	Netherlands Kellogg Continental (51% owned by M. W. Kellogg, division of U.S. Pullman, Inc.) Verenigde Machinefabrieken	Jan 1973	1st plant in 1976, 2d plant in mid-1976, 3d plant 6 months later	34.0	DSM to get lump sum payment in guilders; balance spread over 4 years with major amount payable in first 2 years. Contract covers FOB cost plus supervision of erection, including basic design, supply of all equipment, construction work, & necessary guidance during initial production stage. Training: DSM to train 40-50 Chinese technicians in Holland; will send technicians for erection & start-up of each plant.
Fertilizer plant complex 1 ammonia plant Capacity: 330,000 MT/yr 1 urea plant Capacity: 528,000 MT/yr 1 waste water treatment plant other auxiliary equipment Technology: Kellogg/Mitsui Toatsu	Japan Toyo Engineering Mitsui Toatsu Chemical Mitsui & Co. Hiroshima Trading Co.	Apr 1973	1975	42.0	Financing: Japanese Ex-Im Commercial Bank. 20% down payment; 80% in 10 semi-annual instalments over 5 years at 6% per year, payable in yuan. Kellogg to receive payment through Japanese licensee.
Ammonia plant complex (3 plants) Capacity (each): 330,000 MT/yr Technology: Kellogg	United States M. W. Kellogg	Mar 1973	1976	70.0	Spot cash, no financing involved. Normal terms: approximately 20% down, 70% on completion; 10% on start-up.
Urea plant complex (5 plants) Capacity: 480,000 MT/yr Technology: DSM Stamicarbon	Netherlands Kellogg Continental (joint venture of M.W. Kellogg (US) & Verenigde Machinefabrieken)	Aug 1973	1975-1977	56.0	First plant in operation in 1976-1977; others following at 3-month intervals.

Fertilizer complex 1 ammonia plant Capacity: 330,000 MT/yr 1 urea plant Capacity: 528,000 MT/yr Technology: Kellogg	Japan Mitsui Toatsu Chemical Toyo Engineering	Aug 1973	1976	42.0	Financing: Japanese Ex-Im Bank. 20% down payment, 80% in 10 semiannual instalments over 5 years at 6% per year, payable in yuan. Kellogg to receive payment through Japanese licensee as in previous TEC contract.
Ammonia plant complex (5 plants) Capacity (each): 330,000 MT/yr Known locations: (1) Lu-chou (2) Manchuria Technology: Kellogg	United States M. W. Kellogg	Nov 1973	1975-1977	130.0	Cash, no financing involved. Terms: 20% down, 70% on completion, 10% on start-up. Delivery at 3-month intervals to coincide with Kellogg urea plants negotiated in August 1973 (see above); 8 Kellogg plant contracts cover basic design, engineering, procurement, supervision of construction & commissioning. Plants are all for single-steam production based on so-called stripping process developed by Stamicarbon. These are the first contracts for complete process plants awarded a U.S. firm. Negotiations were conducted under license from U.S. Department of Commerce. Locations not yet known. Plants will be largest of kind in world.
Fertilizer complex 3 ammonia plants Capacity (each): 330,000 MT/yr 3 urea plants Capacity (each): 574,200 MT/yr Technology: Topsoe/DSM	France Heurtey Industries Netherlands Dutch State Mines	Feb 1974	1976 (start-up) to 1977	118.0	Terms: 35% down payment; 65% payable over 5 years at 6% p.a. Location: Nanking & Northeast China
Catalyzer plant for hydrogen, ammonia, & methanol Capacity: ---	Denmark Haldor Topsoe	Feb 1974	---	---	
Fertilizer Complex Capacity: ---	Japan Mitsui Toatsu Toyo Engineering	Mar 1974	---	42.0	

Table B-6

OTHER PLANTS

Plant Profile	Country and Firm	Contract Signed	Delivery Period	Value (million $US)	Remarks
Pulp & paper plant Capacity: --- Location: Kwangchow	United Kingdom Cellulose Development Corp., Ltd	Mar 1963	1964	1.4	Terms: 10% down, most of outstanding balance to be paid at each shipment except for 5% payable upon completion of instalation. Service agreement: Contract provided for supervision of construction work, but engineers were never permitted to visit. Agreement stipulated supply of replacement & spare parts.
Industrial alcohol plant Capacity: ---	France Melle & Speichem	Jan 1964	---	3.0	
Palm oil processing plant Capacity: 14,800 MT/yr	Netherlands Stork-Werkspoor	May 1964	---	2.0	
Oxygen plant Capacity: ---	Japan	Sep 1964	---	1.7	
Precision measuring instrument plant Capacity: ---	Japan	Nov 1964	1966	0.8	
Foaming concrete plant Capacity: 150,000 cu m/yr	Sweden International	Dec 1964	---	1.8	
Porous silica plant Capacity: 150,000 cu m/yr	Sweden	Dec 1964	---	1.8	
Hydraulic equipment plant Capacity: ---	Japan	Mar 1965	1966	1.8	
Oxygen plant Capacity: ---	West Germany	Aug 1965	---	3.5	
Condenser plant Capacity: 200,000 condensers/yr	Japan	Sep 1965	---	2.0	
Instrument plant Capacity: ---	United Kingdom	1965	---	1.0	
Bank-note paper mill Capacity: ---	France ENSA (affiliate of Schneider & Arjonari)	1965	---	.424	

Straw cellulose plant Capacity: 62.5 MT/day	Finland	1965	---	---	
Bleached sulphur cellulose plant Capacity: 80 MT/day	Finland	1965	---	---	
Zinc-refining plant Capacity: ---	United Kingdom Rio Tinto Zinc, Ltd	1967	---	---	
Vacuum heat treatment furnace (2 units) Capacity: ---	United Kingdom Wild-Burfield (Pacher-Cowan Group)	1967	---	1.4	
Dynamite plant Capacity: ---	Sweden Nitrobel	Sep 1968	---	---	
Pulp plant Capacity: ---	Finland	1968	---	4.2	
Oxygen plants (3 large) Capacity (each): 10,000 cu m/hr	Japan Kobe Steel Co.	Jun 1972	---	9.74	Should probably be included under Iron & Steel, but linkage not unequivocally established.
Integrated automated corrugated cardboard mfg. plant Capacity: 200 T/day; 66,000 MT/yr	Japan Rengo Co.	Aug 1972	---	.324	Price includes royalty for know-how.
Oxygen plants (2) Capacity: 440 T/day Location: Shanghai & Hsinkang	France L'Air Liquide SA	Feb 1973	---	---	May possibly be related to iron & steel production, but linkage not unequivocally established.
Oxygen (separation processing) plant Capacity: ---	West Germany Linde AG	Feb 1973	---	10.98	Same as for L'Air Liquide immediately above.
Motion picture processing plant Capacity (initial): ∿ 100 million ft of 35-mm color release prints/yr (using technicolor). Location: Peking	United Kingdom Technicolor, Ltd	Jul 1973	1974	8.5	Terms: Cash, 50% down, 40% on delivery, 10% on acceptance. Plant to be designed in UK. For educational & industrial purposes. Training: Technicolor to train Chinese technical personnel.
Cement plant Capacity: 1.2 MT/yr	France Ciments LeFarge SA	---	---	4.5	Still under negotiation in January 1974.

Table B-6 (continued)

Plant Profile	Country and Firm	Contract Signed	Delivery Period	Value (million $US)	Remarks
Ballpoint pen plant Capacity: 300 million pens/yr	United States Chromalloy American Corporation (Alba, SA, a Swiss subsidiary, to design, construct, & operate plant)	---	---	---	
Ball & large roller bearing plant Capacity: ---	Japan Nippon Seiko Co. Koyo Seiko Co.	May 1974	---	103.0	First contract of its kind with PRC. Japan exported some ¥5 billion worth of bearing products to PRC in 1973, a 40% increase over 1972. With this new plant PRC should be able to meet entire domestic demand for bearings.
Freezing plant (plus large number of ice-making machines) Capacity: ---	Norway Finsam	---	Fall 1974-1975	---	Purpose of plant will be to increase freezing capacity of Chinese fishing industry, facilitating transport of substantial proportion of catch to interior. Short term use: additional freezing capacity for export of shellfish to Europe & Japan.
Plant for packaging bulk row sugar Location: Whampoa	Australia Colonial Sugar Refining (CSR) Co. of Australia	Oct 1974	Apr 1975	---	Bagging plant for bulk row sugar located at Townsville, Queensland, is to be reerected at Whampoa so that cargoes of bulk sugar can be bagged after arrival.